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TEAM DIMENSIONS: THEIR IDENTITY,  
THEIR MEASUREMENT AND THEIR RELATIONSHIPS

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report represents the initial phase of a programmatic effort aimed at answering basic questions about the nature of team performance, and the factors affecting it. An extensive literature review on the relationships between various team or group characteristics and collective performance was conducted, and a summary of propositions derived from this literature is presented. In addition, a new conceptualization of team performance is proposed, and a provisional taxonomy of team performance dimensions consistent with this conceptualization is presented.			

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## EXECUTIVE SUMMARY

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### Requirement:

To identify team characteristics that are related to team performance, to develop a taxonomy of team performance that can lend order and meaning to information already available, and to generate hypotheses relating team characteristics to team performance. This basic research represents an initial step to better define what constitutes team, as opposed to individual, performance and to identify the factors which affect it. It is part of a programmatic effort to improve the team element of manned system performance and effectiveness through better training and evaluation. The necessary first step in accomplishing this is to gain a better understanding of precisely what constitutes the dependent variables of concern, i.e., team performance.

### Procedure:

A review of the team/group performance and training literature was conducted and the results analyzed. These analyses, in addition to the authors' experience and background knowledge, were used to develop a conceptual model of team performance, to develop provisional team performance and team task taxonomies, and to identify further research requirements.

### Findings:

The literature review confirmed criticisms that team research suffers from a lack of attention to the dependent variable, team performance, and the immediate stimuli, team task requirements. Research findings conflict and, in many cases, it appears the research has been conducted on individual rather than team performance.

In developing the conceptual team performance model, the authors made a clear distinction between individual task performance and the team performance functions which allow the individual members to function as a unit. The provisional team performance taxonomy is made up of dimensions contained within four categories of functions: orientation, organization, adaptation, and motivation. Example dimensions are "Matching member resources to task requirements," "Response coordination and sequencing of activities," and "Development of team performance norms." The provisional team task taxonomy consists of two dimensions judged to especially determine the extent of requirements for team performance functions: task interdependence and task emergence.

Given the team performance state of the art, the results of this investigation, and overall program objectives, the report concludes with a discussion of six problem areas which require further research.

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## CHAPTER 1

### Overview

#### Objectives

In 1955, Glanzer and Glaser noted that relatively little formal knowledge existed concerning methods of describing and analyzing group or team performance. Today, more than twenty years later, the situation has not improved considerably. In a recent review of group performance effectiveness, Hackman and Morris (1975) state that very little is known about the causes of effective group performance and methods of improving performance. Recent reviews of team performance and training (Wagner, Hibbits, Rosenblatt & Schulz, 1977; Defense Science Board, 1975; Hall & Rizzo, 1975) conclude that the definition and measurement of team performance still present fundamental stumbling blocks to the development of team training.

This final report [for Team Dimensions: Their Identity, Their Measurement, and Their Relationships (Contract No. DAHC19-78-C-0001)] represents the initial phase of a programmatic effort aimed at answering basic questions about the nature of team performance and the factors affecting it, with the ultimate intent of applying such information to mechanisms of concrete problems of team effectiveness -- how to measure and describe team performance, how to develop and train teams, how to predict good and poor team performance, and how to design teams to optimize team performance.

The objectives of this research effort are:

- to identify team characteristics that are related to group performance;
- to develop a taxonomy of team performance that can provide order and meaning to information already available; and
- to generate hypotheses relating team characteristics to team performance.

#### Approach and Organization of the Report

In order to achieve these objectives, an extensive literature review was conducted on group performance and team training. Although these two areas of research have many common concerns, research in each area, for the

most part, has proceeded independently of work in the other. In work as recent as an effort by Thurmond and Kribs (1978) appeals for the incorporation of applicable small group behavior knowledge into such training efforts continue to be made.

The literature review was based on several search efforts. First, computerized data search procedures, such as the Psychological Abstracts Research Service (PASAR) and Sociological Abstracts, were conducted. These computerized search procedures draw from standard publications relevant to group performance, e.g., Journal of Applied Psychology, the Journal of Personality and Social Psychology, Sociometry, Administrative Science Quarterly, and Human Relations. In addition, previously compiled bibliographies (e.g., Hare, 1972; Terauds, Altman & McGrath, 1960) were used. Finally, technical reports on group and team performance and team training were compiled from ARRO's and other libraries, ARI, and from conversations with investigators in the area.

The product of this effort is presented in the next three chapters. Chapter 2 presents a close examination of the research literature examining the relationships between various team or group characteristics (e.g., size or cohesiveness) and team or group performance. No differentiation was made between "teams" and "groups" in this review, and studies were included as long as they were concerned with collective work performance and characteristics of the collective as an entity. The review concludes with a summary of the major hypotheses relating group or team characteristics to its performance that appear to be supported by available literature. In addition it presents a number of fundamental shortcomings in this body of literature, which are seen as blocking further understanding of the area. Chapter 3 attempts to address these concerns. It presents a conceptualization of the nature of team performance and a taxonomy of team performance dimensions. Although this effort was guided to a limited extent by available work, new approaches were required to develop a conceptualization and taxonomy of team performance which could be of greater utility than what already existed. Chapter 3 presents this new conceptual approach to team performance and provides a provisional taxonomy of team performance functions. Finally, Chapter 4 provides recommendations for future research.

## CHAPTER 2

### Group Characteristics and Group Performance

#### A Review of the Literature

##### Introduction and Approach

This literature review examines the results of studies on the relationships between group characteristics and group performance. Group characteristics are defined as those that apply to the group as an entity (e.g., size or cohesiveness), in contrast to characteristics describing the average member in the group (e.g., average age or intelligence). Group performance, likewise, refers to performance of the collective, rather than the performance of individuals, in a group context.

The objective of the review is to provide a substantive overview of what is known about the relationships between various group characteristics and group performance. Methodological critique of the studies reviewed, therefore, is beyond the scope of this chapter. Furthermore, the sheer number of relevant studies made it necessary to limit description of the studies cited to relatively brief statements.

The review is based on two computerized literature searches, the Psychological Abstracts Research Service (PASAR) and Sociological Abstracts. In addition, previously compiled bibliographies (e.g., Hare, 1972; Terauds, Altman, and McGrath, 1960) were also used. This literature search yielded an enormous number of studies. An initial survey eliminated several hundred studies by examination of the group performance variable. The great majority of studies labeled group performance were found to be, in actuality, studies of individual performance in group contexts. Marginal cases which were not clearly "group" nor purely "individual-in-group" studies were kept in for further examination. The selected studies were abstracted and coded, using a standard form (Appendix A), developed for this project. The major variables, measures, and findings of each study were outlined on this form by two psychology graduate students.

The review covers the relationships between group performance and the following major variables:\*

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\* One major area, leadership, was not included due to the magnitude of the area and limitations in project resources.



- Group Size
- Group Cohesiveness
- Intra- and Inter-Group Competition and Cooperation
- Communication
- Standard Communication Networks
- Homogeneity/Heterogeneity in Personality and Attitudes
- Homogeneity/Heterogeneity in Ability
- Power Distribution Within the Group
- Group Training

## Group Size

Group size, defined as the number of members in the group, is probably the easiest group attribute to identify and define. Due to the relative ease of manipulation, group size effects have frequently been examined.

As in most of the group characteristics examined, about half of the studies investigating size effects used problem-solving tasks such as NASA's moon survival task and business games (e.g., Cummings, Huber & Arendt, 1974; Kennedy, 1971). Apart from the problem solving tasks, the second largest group of studies investigating size effects has involved factory work contexts. A large proportion of this second group is comprised of field studies. Group size research has also used model building tasks (Chow & Billings, 1972), vigilance tasks (Waag & Halcomb, 1972) and memory tasks (Seta, Paulus & Schkade, 1976).

Results of studies on the effects of group size on performance are contradictory. Several studies show a positive relationship between size and performance. Taylor & Faust (1952), comparing groups of 2 and 4 members, found that increased size improved performance (indicated by number of answers) on a game of 20 questions, although efficiency (in terms of person-minutes involved) was better with the smaller group. Ziller (1957) asked groups of 2, 3, and 6 members to estimate the number of dots on a card and to choose the most critical factors for the solution of a complex problem. He found that accuracy of estimation and selection improved along with group size. Anderson (1961) used group sizes of 2 and 3 members, and also reported a positive relationship between size and number of answers on an anagram task. In a disjunctive problem solving task, Frank & Anderson (1971) found that group size (using groups with 2, 3, 5, and 8 members) enhanced performance, although the relationship was negative for conjunctive tasks. Using the NASA moon survival problem, Cummings, Huber & Arendt (1974) reported that the quality of solutions increased with size. The groups used had either 3, 4, or 5 members. However, there were no differences between the groups in time to solutions. Goldman (1971) found positive effects for size with groups of sizes 2, 3, 4, and 5 members, on a concept mastery task. Positive size effects have also been reported in studies which did not use problem solving tasks. In a brainstorming task, Bouchard & Hare (1970) found performance increases as group size increased up to nine members. In a vigilance task, Waag &

Halcomb (1972) found that detection performance improved as team size increased from 2 to five members. Cummings & King (1973) found that quality of performance in a manufacturing plant increased with team size ranging from 10 to 37 members.

Studies have also reported negative relationships between size and performance. Marriott (1949), for example, found a negative relationship between group size and productivity in a factory context when the size of groups varied from 10 to 200. Buck (1957) also found a negative relationship between size and productivity in a factory, with groups composed of 9, 16 and 40 members. In another context, a rope-pulling task, Ingham, Levinger, Graves & Peckham (1974) found that performance decreased as group size increased up to 3 members. No additional decrements however, were found with the addition of 4, 5, and 6 members.

Many studies have found no group size effect. Morrisette, Switzer, and Crannell (1965) found no effects for size, when groups of four or five were asked to find a common symbol in a set of cards. Goldman, McGlynn & Toledo (1967) found no effects for groups of 3 and 5. The groups were asked to reach a decision on the correct answer for items on the Terman concept mastery test. Using four different problem solving tasks Shaw & Breed (1971a, 1971b) were unable to find any effects for group sizes of 2, 3, or 4 members. Hackman & Vidmar (1970) found no performance differences between groups of 2 to 7 members. Kennedy (1971) also found no size effects on performance on a business game.

The effects of size on group performance may follow an inverted U function -- the performance may increase as group size increases only up to a point; beyond this point of optimal performance group size has a negative effect on performance. Most studies do not manipulate group size over a large enough range to find this function. One exception was a study conducted by Holloman & Hendrick (1971). In this study, group members were asked to view the film "Twelve Angry Men" up to a certain point, then the group was asked to reach consensual prediction on the jurors' final decisions. The investigators varied group size from 3, 6, 9, 12, and 15 members, and found that the most accurate group predictions resulted from the groups with 6, 12 and 15 members. Of note was their finding that the larger group sizes generally tended to

divide themselves in halves to come up with a decision. The group with nine members was unable to further subdivide their group and had poorer performance than the group with 6 members.

In support of this inverted U function, studies which have reported positive size effects seem to have a maximum of 5 members in the groups, whereas studies showing negative relationships between size and performance involve much larger groups. It should be noted, however, that this apparent pattern may reflect methodological artifacts, rather than real variation. Research showing positive relationships between size and performance have typically involved laboratory studies, while field studies tend to show negative size effects. Field and laboratory studies differ along a number of dimensions. Laboratory studies use ad hoc groups, whereas field studies use pre-existing groups. Laboratory studies use problem solving tasks, by and large, whereas field studies focus on other tasks, such as factory work. In addition, laboratory studies tend to differ from the field studies in the range of group size manipulated. Laboratory studies use small groups, typically ranging from 2 to 5, while field studies involve groups of 10 to 50.

Task effects. The effects of size on group performance may depend on the type of task involved. Steiner (1972) points out that when tasks are disjunctive (i.e., tasks in which group performance depends on at least one person in the group performing the task) or additive (i.e., group performance depends on the combination of individual performances) size would be positively related to performance; the opposite would be true for conjunctive tasks, tasks in which group performance depends on all members performing well. When the task is additive, the additional resources available make the group performance more effective. When it is disjunctive, potential group performance is determined by the best group member; thus increasing size should result in increased performance up to a point where the group is sufficiently large to ensure inclusion of at least one sufficiently capable person (Shaw, 1971). When the task is conjunctive, everyone in the group must accomplish the task; thus the group will be held back by the least competent group member.

The most direct test of this hypothesis is provided by Frank & Anderson (1971) who made tasks conjunctive or disjunctive by the instructions they provided the groups. They found that size (varied from 2 to 8 members) was

positively related to performance on disjunctive tasks, but negatively related to performance on conjunctive tasks (they varied size up to eight members). While not directly testing this hypothesis, other studies tend to support it. Marriott (1949) found a negative relationship between size and performance in conjunctive tasks involving work on an assembly line. Most of the studies that find a positive relationship between size and performance use tasks that are additive (e.g., tasks measuring number of answers -- Taylor & Faust, 1952; Anderson, 1961, or brainstorming -- Bouchard & Hare 1972) or disjunctive (e.g., problem solving tasks -- Cummings et al, 1974; concept mastery -- Goldman, 1971, or vigilance -- Waag & Holcomb, 1972).

Another possible task moderator is task structure. Cummings & King (1973) found with structured tasks performance is positively related to size, while with unstructured tasks, there is no relationship between size and performance. Examination of other studies, however, shows positive (Taylor & Faust, 1952; Anderson, 1961; Bouchard & Hare, 1970) or no (Morrisette et al, 1965; Shaw & Breed, 1971, Felsenthal & Fuchs, 1976) effects for size with unstructured tasks. Mixed results were also found for studies with tasks classified as "structured."

Summary. The effects of group size on performance varies, and may take the form of an inverted U function. The relationship between size and performance is moderated by task type -- additive, conjunctive or disjunctive -- and degree of structure. More research on the moderating effects of the task on the size-performance relationship is needed. The group size research reviewed is presented in Table 1.1.

TABLE 1.1  
GROUP SIZE

Author	Task	Group Size	Performance Measures	Results
Seta, Paulus & Schade (1976)	word memory task		quantity	2 member groups remember more with competition than cooperation and 4 member groups remember more with cooperation than competition
Chow & Billings (1972)	making atom models	3, 4	quantity	positive
Taylor & Faust (1952)	twenty questions	2, 4	quantity	positive
Ziller (1957)	number estimation selection of critical factors for problem solving	2,3,6	accuracy	positive
Anderson (1961)	anagrams	2, 3	quantity	positive
Frank & Anderson (1971)	answering questions	2,3,5,8	quantity	positive for disjunctive negative for conjunctive
Cummings, Huber & Arendt (1974)	Kuon survival problems	3,4,5	quality	positive
Goldman (1971)	Terman concept mastery test	2-5	change	positive
Bouchard & Hare (1970)	brainstorming	5,7,9	quantity	positive
Naag & Halcomb (1972)	vigilance	2-5	quantity	positive
Cummings & King (1973)	tasks in manufacturing plant	10-37	quality	positive
Marriott (1949)	factory work	10-200	quality	negative relationship

TABLE 1.1 (Cont'd)  
GROUP SIZE

Author	Task	Group Size	Performance Measure	Results
Buck (1957)	factory work	9,16,40	change	negative
Ingham, Levinger, Graves & Pecham (1974)	rope pulling	3,4,5,6	quality	negative up to size 3 then leveling off
Morrisette, Switzer find common symbol & Crannel (1965)		4,5	time, errors	no relationship
Goldman, McGlynn & Toledo (1967)	Munderlic	3,5	quality	no relationship
Shaw & Breed (1971a)	placing tokens on squares	2,3	quality	no effects
Shaw & Breed (1971b)	problem solving	3,4	time	no effects
Hackman & Wicmar (1970)	many tasks	2-7	quality	no effects
Kennedy (1971)	business game	3,4,5	quantity	no effects
Holloman & Hendrick (1971)	watching film	3,6,9,12,15	errors	inverted U

### Group Cohesiveness

Group cohesiveness is the resultant of all the forces acting on all the members to remain in the group (Cartwright & Zander, 1960 p. 7). It includes concepts like intermember loyalties, sociometric choice, within-group harmony and identification with the group. The prevalent belief is that group cohesiveness is good for task performance--that cohesive groups are more productive. Research findings on this relationship, however, are mixed.

There are a number of studies supporting the general belief that group cohesiveness and performance are positively related. For example, Goodacre (1951) found positive relationships between sociometric measures of cohesiveness and problem solving scores of combat units engaged in field exercises. Hemphill and Sechrest (1952) also found sociometric indices of crew cohesiveness to be positively related with bombing accuracy scores. Torrance (1955) administered a projective test to bomber crew members, who perceived productive crews to be cohesive in reaction to formal situations. Likewise Goodacre (1953) found that high performing combat units reported significantly more interpersonal relationships, more satisfaction and more pride in the squad than did low performing units. Berkowitz (1954, 1955) also found that cohesiveness and performance were highly related in bomber aircrews. In a study of basketball squads Martens & Peterson (1971) also reported a positive relationship between cohesion and games won. Supporting evidence is also found in industrial settings -- Van Zelst (1952) found that sociometrically constructed teams of carpenters and bricklayers were superior to control groups in terms of labor and material cost.

On the other hand, a number of studies report no significant relationship between cohesion and performance. For example, Deep, Bass, & Vaughn (1967) found no relationship between cohesiveness and profit in a simulated business game. Mednick & Chemers (1972) found no relationship between performance and cohesion among basketball teams. Seashore (1954) found that high producing industrial groups did not differ from low producing groups in cohesiveness.

In addition, negative cohesiveness-performance relationships have also been found. Grace (1954) found that socio-metric measures of member cooperativeness were negatively related to team success. Palmer & Myers (1955) also reported negative relationship between interpersonal closeness and per-



formance of radio crews. Stogdill (1968) in a study of 26 work groups, found that ratings of work group productivity, defined in terms of output volume, was negatively related to cohesiveness, defined as intermember harmony, for 22 out of the 26 work groups. Ten of the negative correlations were statistically significant.

These contradictory results on the effects of group cohesiveness on performance may be explained by an additional finding in the Seashore (1954) study. He found that high cohesive groups were more variable in terms of productivity than were low cohesive groups, and that this variance was due to the performance standards that the group set. Highly cohesive groups can set and carry out their group goals more effectively than low cohesive groups, and these goals may or may not be in the direction of high performance.

These results were similar to those obtained by Berkowitz (1954) who studied the effects of cohesiveness and group standards on productivity in a laboratory task. He found that subjects high cohesive groups increased or decreased their rate of production depending on the group standard, while there was no significant standards effect for subjects in the low cohesive groups. The concept of performance standards is analogous to Stogdill's (1972) concept of group drive. He explains the cohesiveness-performance relationship along lines that parallel Seashore and Berkowitz. Stogdill states that productivity and cohesiveness are positively related only under conditions of high group drive, and they tend to be negatively related under conditions of low drive or routine.

Summary. Group cohesiveness has been found to have varying relationships with group performance. It appears that cohesiveness, per se, is not directly responsible for performance, but that any apparent effects are due to group norms or standards related to performance level. Such norms, therefore, act as intervening variables between cohesiveness and performance. The research reviewed here is summarized in Table 1.2.

TABLE 1.2  
GROUP COHESIVENESS

Author	Task	Performance Measures	Results
Goodacre (1951)	problem solving	quality	positive relationships between cohesiveness and performance
Hemphill & Sechrest (1952)	bombing	quality (accuracy)	positive
Torrance (1955)	bomber crews	quality	positive
Goodacre (1953)	combat units	quality	positive
Berkowitz (1954)	bomber aircrews	quality, errors	positive
Berkowitz (1955)	bomber aircrews	quality, errors	positive
Hartens & Peterson (1971)	basketball	quantity (games won)	positive
Van Zelst (1952)	carpenters & bricklayers	labor cost, material cost	positive
Deep, Bass & Vaughn (1967)	business game	profit	no relationship between cohesiveness and performance
Mednick & Chermers (1974)	playing basketball	quantity	no relationship
Seashore (1954)	industrial groups	quantity	no relationship
Grace (1954)	athletic team	quantity (games won)	negative relationship between cohesiveness and performance
Palmer & Myers (1955)	radar crews	quality	negative
Stogdill (1968)	industrial work groups	volume	negative

### Intra-Group and Inter-Group Competition and Cooperation

Group competition or cooperation is frequently manipulated by offering differential reward systems. Within group, or intra-group competition is induced by offering the best performer in the group the entire reward, while within group cooperation is induced by offering the entire group a reward when the task is completed. Between group, or inter-group, competition is manipulated by offering differential rewards to groups based on their performance. Cooperation is induced by giving all groups the same amount of reward for a completed task.

Studies of intra- and inter-group relations have used a broad range of tasks. Many of the tasks, e.g., games, puzzles, problem-solving, anagrams, and brainstorming are cognitive in nature. In addition, several investigators have employed noncognitive tasks including cutting circles from paper, constructing model homes and word recall tasks. By and large, however, games have been the most frequently used task situation since they lend themselves easily to this manipulation. The studies that follow will be classified into three sections: (a) studies of intra-group competition and cooperation, (b) studies of inter-group competition and cooperation, and (c) both inter- and intra-group competition and cooperation.

Intra-group competition and cooperation. The effects of intra-group cooperation and competition on group performance have been investigated by a number of studies which show mixed results.

The results of some studies show that within-group cooperation may result in better performance than within group competition. An early study of the effects of cooperation and competition was conducted by Deutsch (1949). Five man groups were either evaluated as groups (cooperative) or evaluations were based on individual members' contributions to the group solution (competitive). Poorer outcomes across a range of variable, including productivity, were found for the competitive groups when compared to the cooperative groups. More recent studies have shown similar results. Swinth & Tuggle (1971) reported that group members given a cooperative goal performed better than group members given a competitive goal. Katz, Goldston, & Benjamin (1958) used both noncognitive and problem solving tasks, and found that for one task, groups in the cooperation condition showed better performance than groups in the competition condition. In the other

tasks they found no effects. In a business game Smith (1972) reported that groups with members who were equally rewarded, outperformed groups composed of differentially rewarded members.

Other studies report no effects for cooperation or competition within groups. Thomas (1957), for example, reported no effects in a study where subjects were told that their IQ scores depended on their individual performance (competitive) or group performance (cooperative). Schick & McGlynn (1976) encouraged cooperation or competition in a concept problem and found no effects on this or any of the other variables they tested.

These conflicting results may be due to weak effects of the variable itself, or of its experimental manipulation. Another possibility is that these conflicting results may be resolved by examination of the tasks involved in the studies. It appears that the interdependency requirements of the task may be an important variable affecting the effects of within group competition or cooperation. When the task requires high levels of interdependence among group members, performance is impaired by competition. However, when the task requires low interdependence, competition may improve performance, but the effects are weak. Goldman et al. (1977) discovered that under high task interdependence, intra-group cooperation was better than intra-group competition; with low interdependence tasks, the reverse was true. Miller & Hamblin (1963) varied task interdependency under cooperative and competitive conditions. They found that with high interdependence, differential rewarding decreased productivity. On the other hand, they reported no effects for cooperation and competition on low interdependency tasks. The stronger effects reported by Goldman et al. (1977) may be partly due to differences in the performance measures used. The impact of task interdependence on the link between intra-group relations and performance may be more apparent for measures of quality (used by Goldman et al., 1977) than for time measures (used by Miller & Hamblin, 1963).

Some researchers have investigated the effects of other variables on cooperation and competition. For example, Sampson (1963) varied reward and punishment in a noncognitive task. He found that the individually-sanctioned and individually-evaluated group responded best to reward, while the group-sanctioned and group evaluated group responded best to fine. In another

study, Seta, Paulus, & Schkade (1976) investigated the effects of size and within group competition and cooperation on recall. They reported that two-member groups remember best with competition rather than cooperation and four-member groups remember more with cooperation than competition on a word recall task.

Inter-group cooperation and competition. Between-group competition has not been investigated to the same extent as has within-group competition, although there tends to be agreement between the two sets of studies. Like intra-group studies, research on inter-group relations report that performance is better under the cooperative conditions than under competitive conditions. Hammond and Goldman (1961) investigated the effects of competition and cooperation on group performance. They reported that competition was detrimental to problem solving while cooperation improved group performance. Goldman, Stockbauer & McAuliffe (1977), reported that group performance in an anagram task was better under inter-group cooperation than competition.

Bouchard (1972) investigated the effects of groups composed of high and low interpersonal effectiveness individuals. He found that the group with interpersonally effective members responded to competition, induced by offering the best performing group a financial incentive, while the group with interpersonally ineffective members did not respond to the incentive. Interpersonally effective members may be able to handle competition and use it to advantage, while interpersonally ineffective members can not respond in the same way. However, as yet, this hypothesis needs further investigation.

Intra- and inter-group competition and cooperation. Two investigators have varied both intra-group and inter-group relationships to see if inter-group competition and cooperation affect intra-group cooperation and competition. Smith (1972) used three groups. In one group each member was given an equal share of the winnings (group cooperative), in another group the winnings were divided proportionately to each member's performance but only if that group won the game (group competitive) and in the third group there was competition among members of the group and between individuals in the other groups (individual competitive). He found an equally divided reward system provided the best performance (group cooperative), and the poorest performance as a

group was shown by the group with entirely individual incentives (individual competitive). Goldman, et al. (1977) varied both inter - and intra-group competition and cooperation. They reported that under high interdependence tasks, intra-group cooperation was positively related to performance but was negatively related to performance with low interdependence tasks. This relationship, however, held only in conditions of intergroup cooperation rather than competition.

Summary. The effects of cooperation and competition upon group performance appears to depend on degree of task interdependency. When task interdependency is high it is critical that group members be operating under a cooperative reward system, but if the task has low interdependency, competition may improve performance. Between group cooperation, appears to improve group performance although more evidence is needed in this area. The studies of intra - and inter-group cooperation and competition are summarized in Table 1.3.

Table 1.3  
INTRA- AND INTER-GROUP COMPETITION AND COOPERATION

Author	Task	Performance Measure	Results
Deutsch (1949)			cooperation better than competition w/in group
Swinth & Tugale (1971)	puzzle	quantity	w/in group cooperation better
Katz, Goldston & Benjamin (1958)	many tasks	quality	cooperation better than competition w/in group
Smith (1972)	business game	quantity	equal reward better than competition w/in group
Thomas (1957)	building house	quantity	no effects for w/in group differential reward
Schick & McGlynn (1976)	concept problem	quality	no effects for w/in group
Goldman, Stockbauer & McAuliffe (1977)	anagrams	quantity	under high interdependence w/in group cooperation is best, vice versa w/ low interdependence
Miller & Hamblin (1963)	problem solving	time	with high task interdependence, as differential rewarding increases, productivity decreases, no effects for low interdependence tasks and competitive rewarding.
Sampson (1963)	cutting circles	quantity	individually evaluated group responded best to reward while group responded best to fine
Seta, Paulus & Schkade (1976)	word recall	quantity	2-member group remembers best with competition, 4-member group remembers with cooperation.
Hammond & Goldman (1961)	human relations problem	quality	cooperation better than competition between group
Bouchard (1972)	brainstorming	quantity	high interpersonal effectiveness group respond to competition, not low I-E groups

## Communication

Communication is defined as verbal interaction among group members, which may vary in amount or in type. Amount of communication is a simple indicator of quantity, while type of communication refers to the mode or content of communication. Very few studies investigate both amount and content simultaneously, which is unfortunate, since the effects of these two communication variables are likely to be highly interactive.

Amount of communication. Research on the effects of amount of communication on group performance generally involves two types of tasks: problem-solving tasks typically found in small group research, and vigilance-monitoring tasks. Since these two types of tasks were differentially affected by amount of communication, they will be discussed separately.

Many studies show an overall positive relationship between communication and performance on a range of problem solving tasks when the performance measures used are quantity or quality. A study by Thibaut, Strickland, Mundy & Goding (1960), for example, investigated the effects of communication on the number of correct solutions obtained in a numerosity estimation task. They found that the group that was allowed to communicate among members performed better on the task than the group that was not given an opportunity to communicate with other members. Cohen (1968), studying group decision making on a business problem, found that when the bottom individual in a decision tree has a strong influence on the decision, free communication improves performance. Levine & Katzell (1971) discovered that greater communication among group members was related to better performance in a numerical payoff task. The performance measure used was the payoff score. Shiflett (1972, 1973) compared groups that were allowed to interact to groups that were not allowed to communicate in a cross-word puzzle task, and concluded that there was a positive relationship between number of words solved and communication between members.

Amount of communication had no relationship with performance, however, when time measures of performance were used. Levine & Katzell (1971) showed



positive relationships, using a quantity or quality indicator of performance, but found no effects when time measures were used. Shaw & Caron (1965), using only a time measure, also found no effects on performance due to amount of communication. It appears, therefore, that in problem solving tasks intragroup communication does not slow down the solution process as one might expect. Instead, communication within group allows a better quality solution to be generated with no apparent cost in time.

While communication appears to have positive effects on problem solving tasks, the opposite was generally found among vigilance-monitoring studies. In these studies, subjects were asked to monitor a screen and respond to certain patterns. These studies, which emerge from team training literature, show negative relationships between amount of communication and performance (Briggs & Naylor, 1965; Naylor & Briggs, 1965; Johnston, 1966).

Task effects and amount of communication. The preceding discussion showed that relationships between amount of communication and group performance were affected by the task type (problem-solving vs. monitoring) as well as by the performance measure employed (quantity and quality vs. time). In addition, it appears that amount of structure in a task may account for some of the differences in the results obtained by the studies. The problem-solving tasks which showed positive relationships between amount of communication and group performance are characterized by relatively low degree of structure, compared with the monitoring tasks, which were highly structured and showed negative communication-performance relationships. Several studies support this hypothesis. Steiner & Dodge (1956) found that communication improved performance in unstructured tasks but communication had no effect on structured tasks. Also, Thibaut, et al (1960) found that intragroup-communication is especially critical with unstable task demand; the concept of stability is closely related to structure.

One likely explanation for the moderating effects of task structure on the communication-performance relationship is that tasks which have low structure require more planning and coordinative efforts than tasks which have clear requirements. Communication in unstructured situations, therefore, are likely to be necessary to achieving task success, whereas communication in already structured situations would be superfluous to task interests. In support of this argument, Johnston (1966), who found generally

negative communication-performance relationships, also found that non-task-related communications impaired performance. Similar results were reported by Federman & Siegel (1965). On the positive side, Shure, et al (1962) report when groups were given an opportunity to plan their strategy on an unstructured task, they performed better than groups not given this opportunity.

Content of communication. Very few studies have investigated the effects of types of communication within a group on group performance. As previously noted, Federman & Siegel (1965) and Johnston (1966) found that non-task related communication retarded performance. Federman & Siegel (1973) investigated the different messages in communication and correlated them with productivity in a helicopter team submarine tracking task. They found a positive relationship between performance and increases in (a) activity (process) messages, (b) evaluative messages, (c) phenomenological ("what we'll be doing") messages, and (d) requests for information messages. Overall they found a positive relationship between performance and information, opinion messages and thinking messages and a negative relationship between risk taking messages and performance. Through factor analysis they isolated 3 stable factors in effective communication among team members. They were: (a) leadership control (atmosphere which allows members to give their opinions) (b) probabilistic structure (better teams make tests of probabilities of certain occurrences), and (c) evaluative interchange (communication in which there is an interchange of ideas, proposals and data).

Another study of communication and performance was conducted by Lanzetta & Roby (1960). In this study, the group was required to achieve a certain configuration of lights on an electrical apparatus by appropriate sequencing of member responses. The researchers monitored all communication and constructed a variety of indices, including the categories "volunteering information", "requesting information", "centrality of leadership" and "degree of exclusion" for communication. They found that the number of requests for information was negatively related to performance while the ratio of volunteered to total information was positively related to performance. They interpreted the requests for information as symptomatic of poor coordination in the group, and high volunteering of information as the opposite.

A slightly different approach was taken by McGrath & Julian (1963), who studied negotiating groups. Comparison of high and low success groups showed that successful negotiation groups had significantly fewer negative-affect and negative-feedback messages than unsuccessful negotiation groups. Other findings were suggestive, although not statistically significant -- successful groups had more neutral and fewer negative messages, more positive and less negative feedback and fewer attempted interruptions than unsuccessful groups.

Mode of communication. Two studies have examined the mode of communication in two different contexts. Ochsman and Chapanis (1971) used 3 types of tasks (a) fault finding; (b) class scheduling and (c) part identification tasks. With all three tasks they found that voice communication was the most important communication. Neither typewriting, video, handwriting, nor any combination had a major effect on performance. Briggs & Johnston (1966) looked at mode of communication in the training situation with 2-man radar controller teams. They found that visual communication was the most important type of communication. The inclusion of voice had no additional effect on learning performance.

Summary. The effects of amount of communication on performance depend greatly on the type of task involved, as well as the specific performance measures used. In general, amount of communication is positively related to quantity and quality measures of performance on relatively unstructured problem solving tasks. No significant relationships were found, however, between amount of communication and performance when time measures are used in problem-solving. In addition, communication is negatively related to performance in vigilance-monitoring tasks, which are highly structured in nature.

Studies of content of communication are relatively fewer than those concerned with amount of communication. In general, it appears possible to identify certain types of communication that are related to good team performance, although more research is required before generalized conclusions can be stated. Finally, studies concerned with the effect of communication mode (e.g., vocal, written and visual) are least common of all, and no real conclusions can be drawn at this stage. Table 1.4. summarizes the studies reviewed in this section.

TABLE 1.4

## COMMUNICATION

Author	Task	Performance Measure	Results
Steiner & Dodge (1956)	Building a decision	Quantity, errors	Positive
Thibaut, Strickland, Mundy & Goding (1960)	Numerosity estimation	Quantity	Positive
Shaw & Blum (1964)	Problem solving	Quality	Positive
Cohen (1968)	Business problem	Quantity	Positive
Levine & Katzev (1971)	Choosing payoff of numeral matrix	Quantity, time	Positive, no effects
Hillett (1972, 1973)	Crossword puzzle	Quantity	Positive
Shaw & Caron (1965)	Problem solving	Time	No effects
Briggs & Taylor (1965)	Radar controllers	Quality	Negative
Maylor & Briggs (1965)	Radar controllers	Quality	Negative
Johnston (1966)	Radar controllers	Quality	Negative
Federman & Siegal (1965)	Submarine simulation	Quality	Information and opinion messages increase as performance increases. Risk-taking messages are inversely related to performance.
Lanzetta & Roby (1960)	Make a predetermined pattern of lights	Quality	Requests for information is related to performance; ratio of volunteered to total communication is positively related to performance.
McGrath & Julian (1963)	Negotiation	Quality	Successful group has less negative feedback and negative affect communications

TABLE 1.4 (Cont'd)  
COMMUNICATION

Author	Task	Performance Measure	Results
Ochsman & Chapanis	Problem solving tasks	Quantity	Voice communication best
Briggs & Johnston (1966)	Radar controllers	Quality	Video communication best

### Standard Communication Networks

Standard communication nets refer to the pattern of communication within the group that is permitted by the investigator. Although many forms of networks have been used by various researchers, the most frequently used networks include the circle (in which each member can only communicate with the member of his right or left), the wheel (where each member communicated to a centralized person) and the all-channel network (where each member could communicate with every group member). Typically, the studies used the common symbol problem developed by Leavitt (1951). In this task each member received a different card containing several symbols, and the task was to find the common symbol to the card that each member received. Over half of the studies used the common symbol task, although other problem-solving tasks, e.g., business games and math problems, were also used.

Research about communication networks, mostly conducted in the 50's and early 60's, has declined in popularity in recent times. Several extensive reviews have been written (Collins & Raven, 1968; Glanzer & Glaser, 1961; and Shaw, 1964) about communication networks and the reader is referred to these for more information. The studies discussed here are, by no means, an exhaustive compilation of the studies conducted in the area, but are representative of the major trends in the area.

Many studies indicate that groups with all-channel communication networks have better performance than groups with wheel communication networks. For example, Shaw (1958) found that groups with two-way communication (a form of all-channel networks) performed better than groups with centralized wheel structures in problem solving tasks. This finding was replicated by Lawson (1965) using mathematical problems. Groups with wheel networks, in turn, tend to perform better than groups with circle communication networks. For example, Leavitt (1951) found fewer errors in the performance of groups with wheel networks than groups with circle networks. Morrisette, Switzer and Crannell (1965) and Morrisette (1960) also found that performance by groups using the wheel network had fewer errors and was faster than performance by groups using the circle network.

Findings contrary to these general trends, however, have also been reported by various studies. For example, Christie (1954) reported groups in the circle network were able to reconstruct number lists better than the all-channel network group. Likewise, Christie, Luce & Macy (1952) reported that circle was more accurate than the wheel or chain networks in a common symbol problem. Other studies, e.g., Shaw (1954a), have reported no effects on performance attributable to communication nets.

Several variables have been found to affect the way communication networks influence performance. Organization within the group was one such variable. Guetzkow & Simon (1955), for example, found that although wheel net was faster than the all-channel network, the all-channel network group was faster than the wheel when the former was organized. Guetzkow & Dill (1957) also found that organization is an important variable--groups that did not organize themselves took longer than organized groups. That organization may be more critical than the specific network structure is supported by Lawson (1965). He investigated the effects of switching groups from the all channel to wheel or vice versa, and found that, regardless of the initial net used, switching to another net always resulted in poorer performance. Presumably this occurred because of a disruption of the procedural organization already present in the initial condition.

Lawson (1964) also investigated the effects of random reinforcement on communication networks. He found that random reinforcement resulted in faster times and fewer messages in the all-channel net, however, had no effect on the wheel or circle communication networks. Lawson suggests that the reinforcement added an extra pressure to the members to succeed and since the all-channel net would evenly distribute the pressure, the effects of extra task pressure induced by reinforcement is positive.

Shaw's (1964) review attempts to reconcile the ambiguous findings by attributing the results to task difficulty. He suggested that with simple problems the more centralized structures (such as the wheel) had better performance, but with complex problems, a decentralized structure (e.g., all-channel, circle) had better performance.

On the other hand, Collins and Raven (1968) suggest that the critical task characteristic is the type of problem involved. They report that, for common symbol problems, the most efficient groups arrived at solution using a centralized structure by giving all information to a pre-assigned leader and having the leader solve the problem. In contrast, in mathematical problems, centralization was not necessarily optimal, as the centralized figure may not have the capabilities to solve the problem. With such problems, a centralized structure directed at the leader would be inefficient.

Summary. The results of communication net studies are ambiguous and inconsistent. Findings appear to be extremely specific to the particular experimental situation involved. In addition, the effects of communication networks seem to be affected by a number of variables, e.g., organization, task difficulty and type of problem. Ambiguities in the findings along with the relative lack of utility for applied settings, may have accounted for the recent decline in attention to this area. Table 1.5 summarizes the studies discussed in this section.



TABLE 1.5

## STANDARD COMMUNICATION NETWORKS

Author	Task	Performance Measure	Results
Leavitt (1951)	Common symbol	Errors, time	Wheel better than circle
Shaw (1958)	Problem solving	Time	Two-way communication is best with centralized structure
Lawson (1965)	Math problems	Time	All-channel is faster; switching nets decrements performance
Morrisette, Switzer & Crannel (1965)	Common symbol	Errors, time	Wheel faster than circle
Morrisette (1966)	Common symbol	Errors, time	Wheel faster than circle
Shaw (1954a)	Problem solving	Errors, time	No effects for networks
Christie (1954)	Reconstruction of a number task	Quantity	Circle and chain better than all-channel
Christie, Luce & Macy	Reconstruction of a number task	Quantity	Circle more accurate
Watzlaw & Simon (1955)	Find missing information	Time	Wheel faster than all-channel except when all-channel was organized
Watzlaw & Dill (1957)	Find missing information	Time	When organized all-channel net was fastest
Lawson (1964)	Problem solving	Time, errors	All-channel faster with random reinforcement, no other reinforcement effects for nets

### Homogeneity/Heterogeneity in Personality and Attitudes

This group characteristic is typically created by matching group members on at least one, but possibly more, dimensions of personality and attitudes. The effects of homogeneity have been studied more in the context of group interaction rather than performance. A number of studies have focused on performance, however. Typically different types of problem solving tasks have been used in these studies, although a variety of other tasks, e.g., constructing models, plotting points, monitoring, and summer camp contests have also been used.

Homogeneous or heterogeneous groups have been constructed on the basis of one personality trait or on a personality profile. Many of the studies showing relationships between homogeneity and performance have used the Fundamental Interpersonal Relationship Orientation-Behavior (FIRO-B) test. The FIRO-B is a measure of interpersonal orientation which reflects the characteristic orientation of people towards others. In these studies, compatibility and homogeneity were highly overlapping concepts. Compatible groups were composed of people who had similar orientations towards dependence and personalness. Generally, the studies found that when group members are homogeneous, based on the FIRO-B, performance is better than when they are heterogeneous with respect to their scores on the FIRO-B. Moos and Speisman (1962) for example, found that compatible groups took fewer moves to complete the puzzle (moving rings to pegs) than incompatible groups. Hewett, O'Brien and Hornik (1974) reported better performance on an atom model-building task for groups that were homogeneous on the FIRO-B when compared to groups that were heterogeneous on the FIRO-B. In a unique study, Shalinsky (1969) organized cabins in a summer camp based on the boys' scores on the FIRO-B. He arranged the grouping such that half of the cabins were composed of boys that were homogeneous on their scores on the FIRO-B and the other half of the cabins were composed of boys that were heterogeneous on the scores on the FIRO-B. In both camp singouts and kit-building task settings, he reported that the compatible groups outperformed the non-compatible groups. This study is significant, because the groups were together for a few weeks as compared to most laboratory studies where groups were together for a few hours.

A number of studies have also shown that heterogeneity, with respect to various measures, was positively related to group performance. Hill (1975) compared systems analyst teams and reported that heterogeneous teams (based on FIRO-B scores) were more productive than homogeneous teams. Hoffman and Maier (1961) matched individuals on their scores on the Guilford-Zimmerman Temperament Survey, and found that in most of the problem-solving tasks they used, heterogeneous groups performed better than homogeneous groups. Sorenson (1970) matched subjects within groups on measures of creative potential and social differentiation. He reported that incompatible groups outperformed compatible ones on problem-solving and idea production tasks.

Mixed results have also been shown by various other studies. Altman and Haythorn (1967) matched individuals in groups based on their needs for Achievement, Affiliation and Dominance. As expected, homogeneous need-affiliation groups performed better than did heterogeneous need-affiliation groups. Contrary to expectation, however, heterogeneous need-achievement groups and homogeneous need-dominance groups performed better than their respective counterparts. Another study, by Triandis, Hall and Ewen (1965) reported that groups that were heterogeneous with respect to attitudes towards various issues (e.g., socialized medicine, immortality and war) performed better than did their homogeneous counterparts when they had experience with the task at hand, but were less effective when they were untrained. In another experiment, they formed groups based on attitudes and measures of creativity. The groups were asked to respond to several questions. Results showed that groups that were homogeneous in attitudes and homogeneous in abilities had more creative compositions than other groups. Tuckman (1967) created groups based on a measure of conceptual system abstractness and dominance level. They found that groups that were of intermediate heterogeneity, (i.e. homogeneous on Abstractness and heterogeneous on Dominance) were the best performers in an unstructured task and were the worst performers on the structured task.

These contradictory results are not surprising when one considers the great number of personality traits that can be used as the basis for creating homogeneity or heterogeneity in groups. In his review of various aspects of group composition, Haythorn (1968) states that "the effect of homogeneity vs.

heterogeneity depends critically on the operational definition used, what the nature of group similarity or heterogeneity is, the nature of the task and the nature of the dependent variables measured" (p. 113).

Task effects. It appears likely that task characteristics may be one important mediator of the relationship between homogeneity and performance. The research surveyed seems to indicate that heterogeneous groups perform better with cognitive tasks (e.g., Tuckman, 1967; Hill, 1975; Hoffman & Maier, 1961), while homogeneous groups outperform incompatible groups on noncognitive tasks (e.g., Shalinsky, 1969; Hewett et al, 1974; Schultz, 1955). However, this hypothesis has yet to be empirically tested.

Another aspect of the group task that may affect the impact of homogeneity or heterogeneity is task structure. Tuckman (1967) reported that heterogeneous groups did best on unstructured tasks and poorest on structured tasks. Generally, the other studies show support for this notion. Most of the investigators that employed structured tasks (e.g., Schultz, 1955; Shalinsky, 1969; Hewett, et al, 1974) report that homogeneous groups were better performers. In contrast, studies that find heterogeneous groups perform better, have employed unstructured tasks (e.g., Hoffman & Maier, 1961, Hill, 1975, Sorenson, 1970). An explanation may lie in a study by Hoffman (1959) who found that conflict arising from heterogeneity increased the frequency of higher quality solutions. In unstructured problem-solving tasks, heterogeneity may stir up a degree of conflict that is helpful to problem-solving. Another explanation, parallel to one made for the effects of size on performance (Shaw, 1972) is that heterogeneity makes more likely the availability of whatever is necessary to accomplish a task. A third task aspect has been investigated but with no real findings. Investigators who have manipulated task interdependency have found no interaction with group homogeneity (Schultz, 1955; Hewett, et al, 1974). Hewett, et al, (1974) did find that groups worked faster on complementary tasks than additive tasks.

In addition to the task itself, it seems that some performance measures are more likely to reflect the effects of homogeneity than others. Time-based measures tend to show no effects for homogeneity (e.g., Moss & Spelman, 1962; Shaw & Harkey, 1976; Hoffman & Maier, 1961), while studies involving

quality and quantity measures of performance seem most likely to be affected by homogeneity. To what this pattern is due, however, is unclear.

Summary. The effects of group homogeneity and heterogeneity on performance appear to be complex, and highly dependent on the dimension in question as well as the task involved. In general, it seems that heterogeneity has favorable effects on performance when a variety of resources are required for performance, and when the exact requirements of the task are not obvious. On the other hand, homogeneity is helpful when tasks are well specified, and the major requirement is one of coordination. Table 1.6 summarizes the studies reviewed in this section.

TABLE 1.6

## HOMOGENEITY/HETEROGENEITY IN PERSONALITY AND ATTITUDES

Author	Homogeneity Dimension	Task	Performance Measure	Results
Moos & Speisman (1962)	Interpersonal orientation	Move rings to pegs (puzzle)	Quantity, time	Positive for quantity, no effects for time
Hewett, O'Brien, Gordon & Hornik (1974)	" "	Atom models	Quantity	Positive
Shalinsky (1969)	" "	Camp contests	Quantity	Positive
Hill (1975)	" "	Systems analysis	Quality, quantity	Negative
Hoffman & Maier (1961)	Personality profile	Problem solving	Quantity, time	Quantity=negative; time=no effects
Sorenson (1970)	Creative potential social differentialia- production tion	Problem solving	Quality	Negative
Altman & Haythorn (1967)	Need for achievement affiliation, dominance	Decoding task	Not specified	Negative
Triandis, Hall & Ewen (1965)	Attitudes or values		Quality (creativity)	Negative
Tuckman (1967)	Level of abstractness dominance	Plot points problem solving	Quality, quantity	Negative
Schultz (1955)	Personal attitude	Model building problem solving	Not specified	Positive
Hoffman (1959)	Personality profile	Problem solving	Quality	Positive
Show & Harkey (1976)	Congruence with leader	Problem solving	Quality, time	Quality=positive; time=no effects

CODE--positive means positive relationship between homogeneity and performance

negative means the more incompatible (heterogeneous) groups were better than homogeneous groups

### Homogeneity-Heterogeneity in Ability

Groups have been made homogeneous or heterogeneous by matching members on their ability levels as reflected by the test scores. When groups are homogeneous in ability, the research results support common-sense expectations that homogeneous groups composed of high ability members outperform medium or low ability groups, (e.g., Klaus and Glaser, 1970; Graham and Dillon, 1974; Shiflett, 1976; Terborg, Castore and DeNinno, 1976). While homogeneity is a factor in such comparisons, however, the critical variable is ability level in the group, rather than homogeneity. Studies that investigate ability variation within the group show more interesting results.

The studies which vary ability within the group show, in general, that groups that are heterogeneous with regard to ability, perform better, given the same average ability level, and have greater gains over individual performance than groups that are homogeneous.

These results were found by a series of studies conducted by Goldman and his colleagues. Goldman (1965) formed two-person groups that were heterogeneous or homogeneous (based on scores on the Wunderlic Intelligence test) and instructed them to reach consensus on answers to another version of the Wunderlic. When the average ability of the group was controlled, the heterogeneous pairs performed better than the homogeneous pairs, and there were greater average gains over individual performance among the heterogeneous pairs compared to the homogeneous ones. He showed that subjects who worked with others above their level improved their performance, while subjects who worked with others at the same or lower levels of ability did not improve.

Similar results were found by other studies. For example, Goldman, (1966) and Goldman, Dietz and McGlynn (1968) also found greater average gains over individual performance for heterogeneous groups when compared to homogeneous groups. Goldman, McGlynn & Toledo (1967) also found that putting individuals together who had different Wunderlic scores improved performance. However, it was always detrimental to the group to include more than one person with the same wrong answer. Johnson and Torcivia (1967) found the same results using a different task. They formed problem-solving groups and found that performance improved, when teams were made up of one member with the right

answer and another member with the wrong answer. Performance did not improve, however, when both members had the wrong answer, even when the wrong answers were of two different kinds.

Using a different basis for measuring ability homogeneity, Laughlin and Johnson (1966) found that while groups composed of two individuals with high ability (defined by the Terman concept mastery test) performed best, groups composed of high and low, or high and medium ability members improved the most. Laughlin, Branch and Johnson (1969) replicated this finding using groups of three. Heterogeneous groups were clearly superior to the homogeneous groups, the one exception being that the homogeneous groups composed of three high ability members had the best performance.

Summary. While the evidence is not extensive, in general, research in this area seems to show that groups composed of members with diverse abilities perform better than groups composed of members with similar abilities. Table 1.7 summarizes the studies reviewed in this section.



TABLE 1.7  
HOMOGENEITY-HETEROGENEITY OF ABILITY TO PERFORM TASK

Author	Task	Performance Measure	Results
Klaus & Glaser (1970)	Acquiring environment-state information	Time	High ability groups did best
Graham & Dillon (1974)	Brainstorming	Quantity	High ability groups had more ideas than lows
Shiflett (1976)	Crossword puzzle anagrams	Quantity, time	High ability better than lows; as ability declined so did distinction between easy and difficult tasks
Terborg, Castore & DeNinno (1976)	Surveying class	Quality	High ability did better
Goldman (1965)	Wunderlic	Change	Heterogeneous groups improved
Goldman (1966)	Wunderlic	Change	Heterogeneous groups improved
Goldman, Dietz & McGlynn (1968)	Wunderlic	Change	Heterogeneous groups improved
Goldman, McGlynn & Toledo (1967)	Wunderlic	Change	Heterogeneous groups improved
Johnson & Torcivia (1967)	Problem solving	Quantity	Heterogeneous group improved
Laughlin & Johnson (1966)	Terman concept mastery test	Change	Heterogeneous groups improved most
Laughlin, Branch & Johnson (1969)	Terman concept mastery test	Change	Heterogeneous groups improved most

### Power Distribution Within the Group

The power distribution within the group refers, in large part, to the hierarchical structure within the group. Other concepts which have been used in similar, though not identical, fashion are degree of centralization, authority structure, participation, and leader-centeredness vs. group-centeredness.

One approach to studying the effects of power distribution on performance is field experimentation. The most well known of the experiments on democratic leadership were those by Lewin, Lippitt, & White in the 1930's (White & Lippitt, 1960) on after-school clubs of ten year old boys. These clubs were exposed to 3 different styles of adult leaders -- autocratic, democratic, and laissez-faire. Of the three conditions, the laissez-faire condition was least efficient, productive and satisfying. The study also found that productivity, (measured by the amount of work done) was greater in the autocratic condition, whereas motivation (measured by continued work after leader departure, and affective measures of hostility, aggression and scapegoating) was higher in the democratic condition.

Other studies have followed up this early study. Another classic field study (Coch & French, 1948) compared three conditions in a factory -- no participation by work group in plans to implement changes, participation through representation and total participation. They found that in the "no participation" condition, production dropped and additional signs of hostility and turnover were manifested. There was no such resistance in the other two conditions, and the "total participation" group recovered more rapidly than the "representation" group and even surpassed their previous efficiency ratings.

Finally, an even larger scale study was conducted by Marrow, Bowers & Seashore (1967), in an effort to rehabilitate a failing manufacturing plant. The study employed a multi-dimensional approach to effecting change including a large element devoted to increasing participative practices in the plant. While the sheer number of variables manipulated make it difficult to assess the impact of each one, this study concludes that participation was highly influential in improving overall productivity and other outcomes.

These large field studies provide initial support for the positive effects of participation on performance. However, they are still extremely limited

and further investigation along these lines is required. Smaller-scale studies have also been conducted which tend to support the positive effects of participative atmosphere on performance. For example, Goodacre (1953) found that better-performing combat crews perceived their group structure to be less hierarchical than crews that performed less well. Members of the less hierarchical groups were also more willing to take initiative without the formal authority to do so. In a laboratory study, Pepinsky et al. (1958) had stooges support a participant or leader-centered atmosphere. The study found that decision quality increased when stooges were supportive of a participative climate. Rosenbaum & Rosenbaum (1971) also found that groups with democratic leaders performed better on a variety of tasks than groups with authoritative leaders.

The relationship between power distribution and performance has been shown to be moderated by a number of variables. Goldman, Bulen & Martin (1961) for example, examined the moderating effect of reinforcement on the relationship between the power structure (centralized vs. de-centralized) and performance. They found the best performance occurred when there was no leader and a reward was offered. The poorest performance occurred when there was no leader and no reward was offered. Goldman, et al. suggest that when a leader is to receive a reward for his performance, the other members feel the burden should be on the leader and tend to hold back. The leaderless groups do not have this inhibition, and therefore were more efficient when offered a reward than the leadered groups.

Bass (1963) investigated the interactions among power distribution, participation, motivation and group performance. When members were equal in status there was a positive relationship between high member participation and decision accuracy, particularly with high member motivation. However, when groups were stratified, high participation decreased accuracy within groups, especially with low motivation.

Individual personality characteristics have also been shown to be moderators in the power distribution-performance relationships in a group. Shaw (1959b) found that in an undifferentiated or decentralized structure mean individual prominence score correlated negatively with a quality score, whereas in the authoritarian group with a centralized power structure there was no relationship between

mean individual prominence score and performance. Shaw suggests in an authoritarian group the members' individual prominence score is unimportant since the leader makes the final decision. Wilson, Aronoff & Messe (1975) investigated the effects of esteem and safety oriented groups and group power structure. They reported that esteem oriented groups performed better with egalitarian structures and safety oriented groups performed better in hierarchical structures.

The moderating effects of task structure on the relationship between power distribution and group performance have also been studied. Rosenbaum & Rosenbaum (1971) used two tasks (alphabetizing, and a draw-cut-past task) to represent high structure tasks where the processes were well defined, and two other tasks (judging whether syllogisms were true or false doing an interaction process analysis) to represent unstructured tasks. Contrary to their hypothesis, democratic groups did not perform better on unstructured tasks, nor did authoritarian directed groups increase their performance on structured than unstructured task. Their hypothesis that democratic groups would perform better in unstructured tasks and leader-centered groups would perform better in structured tasks seems intuitively plausible, and may not have been supported because the tasks they used confounded level of difficulty with degree of structure. More research is needed to test this hypothesis.

Summary. Research on the effects of power distribution within a group and group performance is still rather limited at present. In general, however, there seems to be evidence that even distribution of power, as manifested in decentralization, democratic leadership, and participative climate, is positively related to group performance. However, this relationship is not a simple one. It appears to be moderated by a number of variables, such as group member personality, reinforcement and the task. Table 1.8 summarizes the studies discussed in this section.

TABLE 1.8  
POWER DISTRIBUTION

Author	Task	Performance Measure	Result
White & Lippitt (1968)		Quantity	Productivity better in autocratic leadership
Cohn & French (1948)	Factory	Efficiency	Best performance by high participation group, poorest by no participation group
Harrow, Bowers & Seashore (1967)	Factory	Quantity	Participation influential in improving performance
Goodacre (1953)	Combat crews	Quality	Better performance with less hierarchical group
Pepinsky, Memphis & Shevety (1958)	Business game	Quality, quantity	Better quality result with participative atmosphere; quantity--no effects
Rosenbaum & Rosenbaum (1971)	Syllogisms	Time, quantity	Democratic group better than authoritarian
Goldman, Bulen & Martin (1961)	20 questions	Quantity, time	Best performance with no leader and reward
Bass (1963)	Rank order words	Time	Egalitarian structure--high participation improves performance, vice versa with stratified group
Shaw (1959b)	Target guessing	Quantity	Negative correlation between individual prominence and performance in democratic group
Wilson (1975)	Model building	Quantity	Esteem-oriented group performed better when egalitarian in structure; safety-oriented groups performed better with hierarchical structures

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## Group Training

Group training refers to training that is given to the group, as a group, and may focus on group interpersonal skills as well as on task related skills. It is distinguished from individual training in that the latter is defined as training provided to group members as individuals; such training typically focuses on task related skills. This review of group training effects on performance is divided into two general areas: a) studies that have compared trained groups vs. untrained groups and b) studies that investigate training characteristics. The review does not include studies of T-groups or any other types of interpersonal laboratory training.

Trained vs. untrained groups. There is much evidence to support the positive effects of group training on performance. Lawrence and Smith (1955) found that groups given training in goal setting in a factory setting had better performance as compared to control groups that merely participated in group discussions. Fox and Lorge (1962) found positive effects for group training in efficient problem solving techniques, in a task that required groups to plan morale and efficiency at weather stations in the Arctic. Hall and Watson (1970) investigated training groups to define and legitimize new forms of procedure on the NASA Moon Survival Task. They reported that instructed groups had qualitatively better solutions than uninstructed groups. Nemiroff and King (1975) also found that, given instructions outlining group decision-making procedures, groups made higher quality decisions in the NASA Moon Survival Problem, although they took 50% more time to solution than uninstructed groups. Maier (1972) also found that groups given training in problem solving tasks showed significant increases in solutions' quality after training.

Group training in various team skills has also been shown to improve group performance. Johnston (1966) found that team performance was a positive function of training in coordination skill given the teams in a radar control task. Groups that were given no coordination skill training performed more poorly than groups that received such training. McRay (1966) also found that coordination training produced more effective team performance than individual training alone. Finally, Siegel and Federman (1973) reported better performance in a simulated submarine tracking task for groups trained in communica-

tion than untrained groups, although the differences were not statistically significant.

Thus, many studies have demonstrated the importance of group training in problem solving as well as non-cognitive tasks. However, training appears to have no positive effects on brainstorming tasks. Rotter and Portugal (1969) found that groups given individual or group training performed more poorly than unstructured groups on a brainstorming task. Bouchard (1972) found no effects for training in a brainstorming problem, while Dillon, Graham and Aidells (1973) found that videotape training actually had negative effects--training led to fewer ideas.

Group vs. individual training. Some investigators have compared group training to individual training, and results are conflicting. Horrocks, et al. (1960) in a 6-man decoding task, found no differences between groups trained together or individually. Briggs and Naylor (1964) trained team members individually, with no interaction among group members, or with interaction permitted. The group that was not allowed to interact was superior on a transfer task to the group that was encouraged to communicate with each other. McRay (1966) however, found that groups trained as intact groups on problem solving tasks were more effective than when the groups were composed of members who were trained separately. It appears that the interaction requirements of the task determine whether group or individual training is more effective. A recent review of team training, (Wagner, et al, 1977) concludes that group training would probably be more beneficial than individual training when tasks are emergent and require coordination. However, if the task is established and requires no interaction, then group training is either good or poorer than individual training.

Training characteristics. The effects of various training characteristics have been investigated by a number of studies. One characteristic, training fidelity, has been shown to affect performance, but only in the short term (Briggs & Naylor, 1964, 1965). Fidelity is defined as the similarity of training task to transfer task. In addition, Briggs and Naylor (1964) found that the response aspects of fidelity were short-lived, whereas stimulus fidelity remained important throughout four transfer sessions. In 1965, they found that high fidelity was important when groups were allowed to communicate during

training, but fidelity had no effect when the group was not allowed to communicate. However, the effect of communication availability disappeared after the third session on the transfer task. Briggs and Naylor (1965) also found that groups allowed to interact during training were superior to those not allowed to communicate, although, again, the effect of the training condition did not last after the third session.

Another important aspect of group training that has been investigated is part-task vs. whole-task training. Schwartz and Philippatos (1968) gave groups training on separate components of a complex task, numeral matching. They found that training on the separate components failed to improve overall performance on the complex task.

Klaus and Glaser (1970) gave individuals training on a coordinate light-switching task, and then formed teams which were given group training directly after or a month after the individual training sessions. No effects were found for this variable, delayed vs. immediate group training.

Summary. In general, group training is helpful when it is focused on the specific demands of the task, and in cases when the tasks require interaction. In addition, training in various team skills such as coordination and communication appears helpful to team performance. In brainstorming tasks, training does not seem to improve group performance.

Studies of training characteristics may have important implications for training design. Training on separate components of a complex task did not appear to be helpful to overall performance. No lasting effects were found for training fidelity nor delayed vs. immediate group training. However, more studies are needed to assess the generalizability of these findings. The studies on group training reviewed here are presented in Table 1.9.



TABLE 1.9  
GROUP TRAINING

Author	Task	Performance Measure	Results
Lawrence & Salth (1955)	Order checkers	Quantity	Positive effects for goal setting training
Fox & Lorge (1962)	Problem solving	Quality	Positive
Hall & Watson (1970)	Moon survival problem	Quality	Positive
McInroff & King (1975)	NASA moon survival	Quality	Positive
Haier (1972)	Problem solving	Quality	Positive
Johnston (1966)	Radar controllers	Quality	Positive effects for coordination training
McRay (1966)	Radar controllers	Quality	Positive effects for coordination training
Siegel & Federman (1973)	Tracking task	Quality	Slight positive effects (not statistically significant) for communication training
Bouchard (1972)	Brainstorming	Quantity	No effects
Dillon, Graham & Aidells (1973)	Brainstorming	Quantity	Negative
Briggs & Naylor (1964)	Radar controllers	Quality	Response fidelity only lasts to the second session; however, stimulus fidelity remains important
Briggs & Naylor (1965b)	Radar controllers	Quality	Training had no effects after the second session, regardless of fidelity
Schwartz & Philippatos (1968)	Each member contribute to make a specified sum	Quantity	No effects for part-task training
Klaus & Glaser (1970)	Sensing when to press button	Quantity	No effects for delayed and immediate group training

### Summary and Discussion

A number of substantive relationships between group characteristics and group performance emerge from this review of the literature. In most cases, the relationships are not straight forward, but appear to be moderated by a variety of factors. Many of these relationships, in addition, are derived from the literature, and require direct testing. The following propositions summarize the major relationships derived from the literature review:

1. The relationships between group size and performance are moderated by the task.
  - a. In disjunctive and additive tasks, size is positively related to performance.
  - b. In conjunctive tasks, size is negatively related to performance.
2. The relationship between group size and performance may follow an inverted U function for certain tasks. That is to say, performance may increase as group size increases only up to a certain point, beyond which group size has a negative effect on performance.
3. Group cohesiveness is positively related to group performance only when group norms and standards are favorable to high levels of performance.
4. Intra-group cooperation, rather than competition, is positively related to group performance when the task requires high levels of interdependence among group members.
5. Inter-group cooperation, rather than competition, is positively related to group performance, although the results are less consistent than those for intra-group relationships.
6. Communication has positive effects on the performance of problem-solving and other unstructured tasks, but has negative effects on highly structured tasks.
7. Communication that is task-related improves performance but non-task-related communication impairs performance. (The distinction, however, may be difficult to make in real life.)

8. Homogeneity in personality and attitudes appears to have favorable effects on relatively structured non-cognitive tasks, whereas heterogeneity appears to have favorable effects on unstructured, problem-solving tasks. However, the effects of homogeneity and heterogeneity also depends on the particular dimension on which homogeneity or heterogeneity is measured.
9. Groups that are heterogeneous in ability appear to perform better than homogeneous groups in cognitive tasks, when the average ability level in the group is controlled.
10. Egalitarian distribution of power tends to be positively related to performance. However, the relationship appears to be complex and is affected by personality, task, motivation and reinforcement variables.
11. Group training facilitates group performance on tasks that require interaction.
12. Group training on team skills appears to improve group performance, although there are still relatively few studies in the area.

One major observation emerging from this list of propositions gleaned from the research literature is the contingent nature of most of the relationships between various group characteristics and performance. Thus, the development of a truly universal set of statements relating group characteristics to performance does not appear to be a realistic goal. Instead, we suggest that future efforts direct themselves to addressing the nature of the contingencies that affect the relationships of interest.

A critical variable moderating the relationships between various characteristics and performance is the nature of the task on which performance is measured. Although the review shows the importance of the task in the study of group performance, it also shows that by and large, there has been very little research emphasis on the effects of the task on performance. In the typical study, the group task is carefully specified, a priori, and tasks are not sampled within a study (Hackman & Morris, 1975)--in effect the task is held constant in these studies. In addition, the choice of the task in many studies is arbitrary, and the task merely serves as an auxiliary vehicle

by which the manipulated group characteristics can be studied. This is particularly true of laboratory experiments.

The casual treatment of the task has several implications. First, too little is known about the role that the task plays in mediating the relationships between group characteristics and group performance. Further research in this area seems to be called for. Second, there has been inadequate effort devoted to the dimensions critical to group performance along which group tasks may vary. Steiner's (1972) typology of group tasks is an important contribution in this area, as are distinctions made by human factors researchers, e.g., Wagner et al. (1977) and Boguslaw & Porter (1972). More emphasis on developing such task taxonomies would provide insights for future research which includes variation of task dimensions in the research design.\*

In addition to the nature of the task, the review also shows the importance of the types of performance measures used in the studies. While many studies use only one type of performance measure, when more than one is used, the relationship between group characteristics and group performance often differ depending on the type of measure used (e.g., quantity vs. quality). Since several alternative measures of performance are possible in any given task situation, the relationships and trade-offs among different types of performance indicators deserve further study. In natural settings, the relative importance of different measures of performance is determined just as much by policy and politics than by the task situation itself. Greater clarity on the empirical relationships of various measures would help rationalize the process of setting priorities among performance criteria.

A second general observation about the literature reviewed concerns the considerable imbalance existing between attention paid to the independent variables, group characteristics, and that paid to the dependent or

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\*This conclusion parallels that reached in recent efforts linking individual differences, learning and performance (Fleishman, 1975; Fleishman & Hogan, 1978).

criterion variable, group performance. Much effort has been devoted to conceptualizing and operationalizing the various factors that affect group performance, without a parallel level of effort devoted to understanding the basic question, what is group performance. One indicator of the neglect of the group performance variable is the number of studies which refer to "group performance" when the actual object of study is individual performance in a group context. This distinction, in fact, is one that is not explicitly dealt with in most of the research on group performance. Thus it is difficult to distinguish what is an aggregation of the performance output of individuals (multi-individual performance) and what is truly an output of the group as a collective. To a large extent, the nature of group performance remains a black box, and what we have are measures representing different aspects (e.g., quantity, speed) of functions that are inadequately understood. This problem is a basic one, which has its roots in the even more fundamental issue of defining the activities of a group or any type of social system. As Steiner (1974) so aptly puts it, we are better equipped to see the trees than the complexity of the forest. It is easier to describe and measure the behaviors of individual group members, than to describe and measure the patterning of events and mutual responsiveness that can make group performance more than the isolated performance of group members.

The review shows that the amount of solid information available on the relationships between group characteristics and group performance is not commensurate to the mass of research conducted in the area. We suggest that much progress can be made in the study of group performance by attending to our two general observations:

- 1) that the relationships between group characteristics and group performance are contingent on various factors, particularly the task on which performance is measured, and
- 2) that insufficient attention has been focused on understanding the nature of group performance itself.

The following chapter addresses these two concerns. It proposes a conceptualization of group or team performance which differentiates between the individual and interactive components of performance, and describes the major classes of variables which are seen as affecting overall performance.

## CHAPTER 3

### Team Performance: A Model and Provisional Taxonomies

The research reviewed in Chapter 2 shows that efforts to determine the effects of various factors on group or team performance are severely limited by a basic lack of understanding of the nature of the criterion--collective performance. While a precise understanding of what one is trying to predict should be the starting point in any problem of human performance prediction (Finley, Obermayer, Bertone, Meister & Muckler, 1970), the literature reviewed has tended to bypass this essential step. Chapter 2 also shows that the bi-variate approach taken by much of the research cannot provide adequate understanding of the relationships between characteristics of the group or team, and collective performance. A more complex approach is required, which considers the various interactions among the factors affecting performance.

Chapter 3 begins to address these concerns--it provides a working definition of the performing collective, the work team, and presents a new conceptualization of team performance and performance antecedents. This team performance model describes major variable classes that are expected to have direct and indirect effects on performance. In other terms, the model provides a series of general hypotheses regarding the major variables that interact to determine team performance. In addition, Chapter 3 presents a provisional taxonomy of team performance dimensions and a provisional team task taxonomy based on our conceptualization of team performance.

### Definition of Team

One major problem in research on team performance is the lack of clarity surrounding the "team" concept. As Wagner et al.(1977) note, usage of the term "team" tends to be arbitrary, without any standard boundaries. Teams may be composed of two or more individuals and may be characterized by various degrees of formal structure and permanence. It is frequently unclear whether the team is simply a collection of individuals performing separate jobs in a group context or whether it has an existence over and above the individuals in it (Hall and Rizzo, 1975).

Various authors provide definitions for "teams":

- "A task-oriented organization of individuals interacting to achieve a specific goal." (Horrocks & Goyer, 1959)
- "It is considered to be relatively rigid in structure and organization with a well defined number of tasks, roles, and communication links." (Klaus & Glazer, 1968)
- "Three or more persons working in concert toward a common, identifiable and relatively immediate goal." (Daniels, Alden Kanarick, Gray & Reuge, 1972).

In addition, Glaser, Klaus and Egerman (1962) offer the following distinctions between teams and small groups:

- "Teams" have the following characteristics:
  1. They are relatively rigid in structure, organization, and communication pattern
  2. The task of each team member is well defined
  3. The functioning of the team depends upon the coordinated participation of all or several individuals.
- In contrast, "small groups" differ in that they generally:
  1. Have an indefinite or loose structure, organization, and communication pattern
  2. Have assignments which are assumed in the course of group interaction rather than designated beforehand

3. The group product can be a function of one or more of the group members involved depending upon the quality and quantity of their participation.

These distinctions parallel differentiations drawn between two types of conceptual models for teams and the context in which team behavior occurs--the stimulus-response model appropriate to established contexts and the organismic model appropriate to emergent contexts (Alexander & Cooperbrand, 1965; Boguslow & Porter, 1962). In an established context, there is high predictability in action-relevant environmental conditions, system-states and consequences of alternative actions. Such conditions make it easy to abstract key variables to be manipulated in stimulus-response fashion for research and during training. In contrast, emergent contexts have considerably less structure and predictability. Although some degree of structure and task clarity exist, they are liable to shift given changing contingencies. The team, therefore, is seen as an evolving organism composed of individuals, among whom interrelationships are relatively fluid.

It appears more useful to conceive of teams as occurring on a continuum of variables, such as amount of structure and predictability, rather than using these characteristics to define what is a team and what is not. The position of teams on these variables would have implications for the types of skills most salient to their particular contexts.

For our purposes, we will define team as:

- two or more interdependent individuals performing coordinated tasks toward the achievement of specific task goals.

This definition of teams has two major components:

- 1) a task orientation shared by all team members, and
- 2) a condition of task interdependence among team members.

Interdependence implies requirements for coordination and interaction among team members. It also implies that "co-action" alone--i.e., situations in which actors perform similar or related tasks, but do not have to interact directly with each other in pursuit of common ends (Davis, 1969)--does not define a team. In this respect, we are making the same distinction between truly "team" situations and "multi-individual" situations made by Wagner



et al (1977) and Collins (1977). In addition, the requirement for coordinated tasks implies that the overall team goal is divisible, to some extent, into sub-components for which various team members are responsible.

### Conceptualization of Team Performance

We view performance as a dependent variable, separate from the performer and from conditions impinging on the performers. By team performance, we mean the goal-directed behaviors/activities/functions accomplished by the team in performing the task, i.e., performance per se. Using the perspective, the performance is viewed as a set of responses separate from the task itself which is regarded as an external set of stimuli. This view of performance is in line with earlier positions taken by Hackman (1968), and Farina & Wheaton (1971), among others.\*

Figure 1 illustrates our basic conceptualization of team performance. It also illustrates the basic classes of variables influencing team performance. Although this model is only a skeletal framework, and not all parts of the model will be addressed by this research, it is presented to provide the context within which this work is embedded.

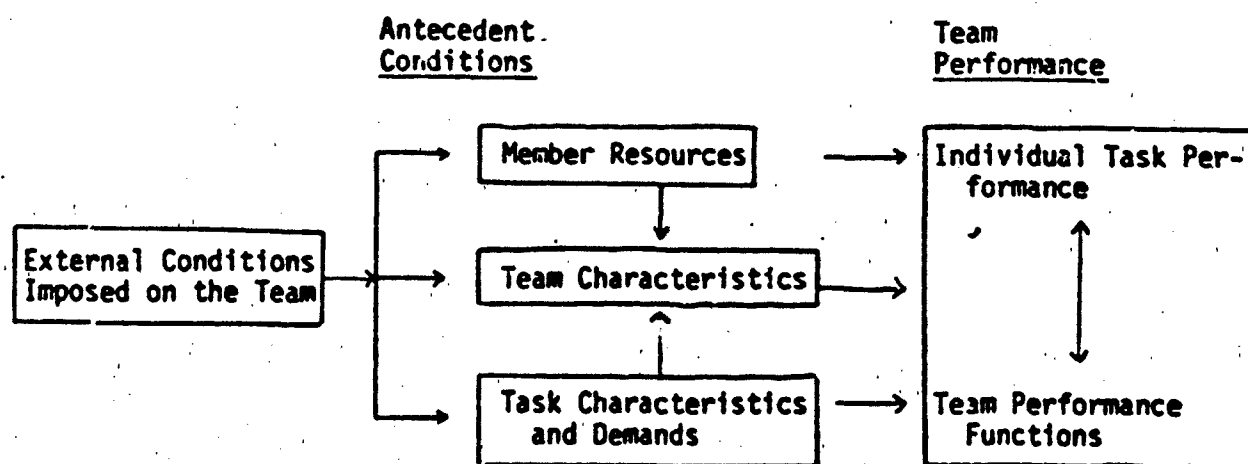


Figure 1. Conceptual Model of Team Performance

\*Footnote: This definition also parallels Steiner's (1972) concept of process, which is defined as all the actual steps taken by an individual or group when confronted with a task. Process is the series of behaviors, each determined by those previously occurring and determining those that follow.

### Components of Team Performance

The figure shows that team performance is composed of task behaviors by individuals and of task-related processes/functions/behaviors at the team level which allow the individual members to function as a unit. Task behaviors performed by individual team members are those which are geared towards the operating or substantive task--e.g., pushing a lever, operating a radio, or detecting a signal, while task-related team functions are those which focus on achieving coordination among individual members and sub-tasks. These team functions are not based on individual acts but on interactions among team members. Separating team performance into these two components follows directions set by Guetzkow and Simon (1955). Early on, they suggested that group problems are not unitary, but must be separated into the "substantive" task and the organizational or "procedural" problem.

The two major components of team performance (individual task behaviors and team functions) determine the final team product, in ways which may differ depending on the particular situation facing the team. Individual task performances may be summed, so that the team product is merely the sum total of individual performances. The additive mode seems to characterize team performance in routine and well established situations (Hall & Rizzo, 1975). Or more complex processes of combination may occur, such that final team output is greater or less than what would have been predicted from individual performances. Gains in the group product have been called "synergistic effects" (Cattell, 1948) or "assembly effect bonuses" (Collins & Guetzkow, 1964), while Steiner (1972) uses the term "process loss" to denote losses due to interaction within the group. Such gains and losses would be expected in situations that are relatively less structured and which require interaction among team members. Since most real teams operate in task situations that have varying degrees of structure and routine, their overall performance would include additive aspects as well as gains and losses due to combination processes.

### Antecedents of Team Performance

Team performance is, in turn, a function of four classes of variables:

- External conditions imposed on the team
- Member resources (e.g., abilities, personalities, etc.)

- Team characteristics (e.g., communication structure, authority structure, cohesiveness, etc.)
- Task characteristics and demands (e.g., disjunctive, conjunctive, additive, complementary, etc.)

Each of these variable classes are discussed in further detail below.

External conditions imposed on the team. Work teams generally exist within the context of a larger system, which controls many parameters affecting the team and its performance. With a few exceptions, team member resources, team characteristics, and team task assignments are determined by people and procedures outside of the team itself. The larger system may have fairly direct effects in team-related matters. Membership in the team, for example, which puts boundaries on the resources available for team work, is most often determined by personnel boards, job analysts and hierarchical superiors. Various characteristics of the team itself (e.g., size, power distribution on authority structure, training opportunities, and homogeneity) are also usually determined by external factors. Finally, the larger organization defines the team task and sets standard operating procedures for task accomplishment.

In addition to the system's direct impact on team parameters, there are indirect effects on the team by its mere embeddedness within the organization. Various organizational conditions, e.g., degree of formalization, clarity of goals, and the overall climate of trust and supportiveness would be expected to influence the actual availability and utilization of member resources and to be mirrored in the team's internal structures and climate.

Member resources. Included here are the abilities and personality characteristics that individual members bring to bear to the team task. Member abilities may range from fairly general ones, e.g., intelligence, to specific proficiencies relevant to the particular task, e.g., blue-print reading proficiency (Bass & Barrett, 1978). Reviews (e.g., Heslin, 1964; McGrath & Altman, 1966) confirm the expected positive relationships between abilities of team members and their performance in the team. Likewise, training literature (e.g., Kanarick, Alden & Daniels, 1971; Wagner, 1977) suggests that individual proficiency is the basis for effective teams. In fact, Kanarick et al. (1971) suggest that individual team members have to be

trained first in the specific of their jobs, and then should be instructed as a unit.

Team members also bring to the task context their personality characteristics. The link between personality and performance may not be as strong and direct as that between abilities and performance. However, various personality traits such as sociability, task orientation and emotional stability may be regarded as general abilities likely to influence performance, particularly performance that involves cooperation among team members (Bass, 1977). A review by Mann (1959) concludes that a number of personality variables (e.g., adjustment, dominance, and extroversion) affect performance in small groups.

Our model shows that member resources affect individual task performances directly. However, as Comrey (1953) noted in comparing individual and team dexterity on a pegboard task:

"Less than half the group performance variance could be predicted from a knowledge of the individual performances, even with the effect of errors removed. It is suggested that manifest differences between the "individual" and "group" tasks, interactions among individuals, and a constellation of abilities in the general area of cooperation may account for the variance not predicted by perfectly reliable individual performance scores." (p. 210)

Our model, therefore, also shows that member resources also affect team performance functions indirectly through their effects on team characteristics.

Team characteristics. As discussed in Chapter 1, team characteristics are defined as those that apply to the team as an entity. Cattell (1948) used the term "syntality traits" to denote the group as a totality, in contrast to "population traits" which refer to the average member of the group--e.g., the average intelligence of members in the group. Examples of team characteristics are: size, communication patterns, team climate, cohesiveness, homogeneity/heterogeneity along various dimensions (e.g., personality, ability, attitudes) and authority structure.

The model suggests that team characteristics are shaped by a number of factors. They are determined partly by member resources. Some aspects of this relationship may be more obvious than others. For example, team homogeneity

or compatibility clearly depends on the characteristics that individual team members bring to the team. Some evidence exists that team climate may be affected by team member characteristics. Haythorn (1968), for example showed that authoritarian - submissive members created authoritarian - submissive team climates. Member characteristics also affect team communication and structure. Russ & Gold (1975) found that when they planted a task expert and a task bungler on a team, the result was centralization and lowering of team communications. There remains, however, a lack of clarity regarding the effect of member characteristics on team characteristics.

The model also shows that team characteristics are affected by task characteristics and demands. Bass (1977) contrasts the differences in team arrangement and composition that might be expected for different tasks such as polishing auto bumpers, steel production and sales. It is conceivable that disagreements regarding the effectiveness of two types of team structures, serial or parallel (Briggs & Johnston, 1967; Briggs & Naylor, 1965; Klaus & Glaser, 1968) could be due to the nature of the tasks investigated. Again, these relationships have not been sufficiently explored by research.

The third factor affecting team characteristics shown by the model involves the external conditions imposed on the team. As the previous section illustrates, team characteristics such as authority structure, team composition, and task assignment within the team are pre-determined by the larger organization within which the team is embedded.

Chapter 2 reviewed the effect of various group or team characteristics on collective performance. The effects of team characteristics are dual: they affect the performance of individual task functions, and also team-level operations. Various studies show the impact of the team on the individual. A well known group of studies conducted at the Hawthorne plant of the Western Electric Company (Roethlisberger & Dickson, 1939) ushered in the era of research addressing the impact of the group on the individual. Examples of this research include a study of group norms and individual productivity (Coch & French, 1948); cohesiveness and productivity (reviewed by Shaw, 1971); and group size and individual performance (reviewed by Shaw, 1971; Steiner, 1972).

In addition to affecting the individual task performance of individuals within teams or groups, the model shows that team characteristics affect team performance functions. A team's authority structure, for example, determines the type and pattern of interchange within the team. Team size affects the opportunities for coordination within the team, as well as the coordination strategies possible (Steiner, 1972). Research is needed to provide empirical support for these relationships.

Task characteristics and demands. Team task characteristics and demands determine the critical demands for successful performance (Roby & Lanzetta, 1958) and influence the interactions that team members have with each other. Tasks specify what kinds of behaviors, activities and processes are permitted and prescribed in the interests of effective performance (Steiner, 1972).

In addition to the demands created by the nature of the task, certain task characteristics are important because they affect individual task performance as well as the operation of team task functions. The impact of task characteristics on individual performance has been demonstrated by a series of studies based on the Job Characteristics Theory proposed in various forms by Hackman and Oldham (1976), Turner and Lawrence (1965) and Hackman and Lawler (1971). The theory and supporting studies show that high quality work performance and other outcomes can be attributed to five core job dimensions: skill variety, task identity, task significance, autonomy and feedback.

Task characteristics and demands also affect team task-related processes. Morris (1966) showed that task type and difficulty significantly affected various aspects of task group interaction such as "structure problem", "propose solution", "clarify" or "seek evaluation." An extension of this study (Hackman & Morris, 1975) showed that task type affected such group functions, which in turn affected characteristics of the written group product (e.g., creativity, originality and quality). Similar results were shown by Sorensen (1971) who found significant relationships between task type and five aspects of the interaction process: structuring, generating, elaborating, evaluating and requesting.

Summary of expected relationships in team performance. The relationships illustrated in the proposed team performance model are complex and depend on the particular variables involved. In very general terms, however, our model hypothesizes that:

- 1) Team performance consists of individual task behaviors and team performance functions
- 2) Team member resources are determined, in large part, by external conditions imposed in the team
- 3) Member resources directly affect individual task performances
- 4) Team characteristics are determined by team member resources, by task characteristics and demands, and by externally imposed conditions
- 5) Team characteristics affect both individual task behaviors and team-level functions
- 6) Task characteristics are usually determined by externally imposed conditions
- 7) Task characteristics affect individual task behaviors as well as team performance functions.

## Provisional Taxonomies

Each of the variable classes described in our model implies a domain that should be mapped out in more specific detail. For this project our primary focus is on developing dimensions of team performance as such\*. The dimensions relevant here are those that enable the team to work together as a unit, over and above individual member performance of specific behaviors. In addition, provisional team task taxonomies relevant to our team performance dimensions have also been initiated.

### Toward a Team Performance Taxonomy

As pointed out earlier, work in defining team performance has been limited thus far. Most of the studies in the small group tradition do not focus on examination of the performance variable, emphasizing instead the various factors that may affect it. In this effort to define the domain of team performance, we will focus on performance dimensions that make effective synchronized work possible. We hope to avoid the undesirable extremes in scope or generality--excessive specificity in any classification system precludes efforts at generalization, while a schema of inordinate generality would never progress beyond the conceptual stage of development (Wheaton, 1968). We are aiming for a system sufficiently broad as to be relevant to a number of different team performance situations, while remaining sufficiently specific for the distinctions made to be meaningful. An implicit assumption we are making is that certain common dimensions underly many apparently diverse team performance situations, which may be exhibited in varying levels, depending on task requirements as well as team proficiencies. A second assumption is that team performance dimensions specific to the team task context may be found to supplement the general dimensions we propose. In sum, we are working towards a middle-level taxonomic system which provides a common metric for team performance situations, but which may require supplementary information when considering specific situations.

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\* Taxonomies which address individual-level functions are not our concern here. Reasonable progress has already been made in developing such taxonomies (Fleishman, 1975). These taxonomies, which vary greatly in specificity, concern, by and large, the specific task content (i.e., what has to be done). Among them are the three-tier taxonomy developed by Berliner et al (1964) which presents processes, activities and behaviors in increasing specificity, Millers' (1967) taxonomy including functions such as scanning and cue-interpretation; and the system developed by Teichner & Fleishman (1971) which includes major functions such as searching, switching, coding and tracking.



Previous research. The team training literature is suggestive of various team performance dimensions which characterize effective work teams. The natures of these dimensions differ slightly, depending on the definition of the research problem--i.e., team processes or functions are referred to when the focus is on understanding what the team actually does in carrying out its task, and team skills are referred to in studies of team training. However, this differentiation is not very meaningful, since the operational definitions of team processes and team skills generally have a great deal of conceptual overlap.

A relatively early work by Lanzetta & Roby (1966) suggests three general functions in group-task performance: orientation, mapping and jurisdiction. Orientation denotes the "fact-finding" function of determining the condition of variables in the task environment and the group's standing on those variables. Mapping is the process by which the group learns the consequences of various alternatives under various environmental conditions. Jurisdiction refers to the process whereby response actions are chosen and decisions implemented. Other team performance dimensions have been studied by other investigators. For example, Boguslaw & Porter (1962) suggest that the analysis of one's own errors as well as teammate errors is an important aspect of team functioning. Another dimension is "team awareness" (Briggs & Johnston, 1967; Kanarick et al., 1971)-- the knowledge about the roles of each team member in relation to team tasks.

Wagner et al. (1977) review various dimensions which they label "team skills." Among them is cooperation, which Alexander and Cooperbrand (1965) describe as a team learning objective. They say:

Learning to cooperate means learning the strengths and weaknesses of one another, learning when the others want help and when they do not want it, learning to pace one's activities to fit the needs of all, and learning to behave so that one's actions are not ambiguous.

This definition of cooperation is highly similar to the concept of "coordination" defined for a study of aircrew skills (Siskel & Flexman, 1962) as the ability of crew members to work together, anticipate each other's needs, to inspire confidence and mutual encouragement and to communicate

effectively. Other studies have found the broad and overlapping dimensions of communication and coordination to be related to effectiveness in some tasks (Johnston, 1966; McRay, 1966). Further insight into the meaning of "communication" was provided by a study of communication and effective helicopter team performance (Federman & Siegel, 1965; Siegel & Federman, 1973). They identified four communication factors in this study: 1) probabilistic structure, 2) evaluative interchange, 3) hypothesis formulation and 4) leadership control. As defined by the authors of the study, probabilistic structure involves processes in weighing alternatives, and in questioning and searching for answers to questions. Evaluative interchange is contained in communications in which there are direct requests for information and opinion, as well as the responses to these requests. Hypothesis formulation categorizes those communications involving interpretations of past performance in the mission and evaluation of the future tactics to be followed. Leadership control connotes provision of an atmosphere where opinions of crew members are allowed to emerge.

These communication factors were incorporated into three team-task learning categories proposed by recent work (Kribs, Thurmond & Mark, 1977; Thurmond & Kribs, 1978). They were:

- Knowledge of team roles, which includes self-evaluation and team awareness
- Team attitudes, which includes team members' confidence of their own abilities, aggressiveness and pride
- Team communication, which includes probabilistic structure, evaluative interchange, hypothesis formulation and leadership control

In contrast to the team training literature, dimensions of group process that are directly relevant to performance have not received sufficient attention in the small group literature (Hackman & Morris, 1975). In general, the systems for categorizing group functions found in this body of literature have been more useful in simply describing group interaction patterns, and have not been very useful in demonstrating the links between various interaction patterns and effective performance. The best known example of such systems is the Interaction Process Analysis System (Bales, 1950) which categorizes both socio-emotional (e.g., "shows tension", "shows solidarity") and task oriented processes (e.g., "asks for orientation"). A similar system

used by Morris (1966) categorizes communications that are directly task relevant (e.g., "proposes solution", "seeks evaluation").

A few studies from this body of research, however, provides some dimensions which are related to effective group performance. For example, Sorensen (1971) showed the relationship between dimensions of group behavior structuring, generating, elaborating, evaluating and requesting, and quality of written group products. Hoffman and Maier (1964) focused on the process by which potential solutions to group tasks are weighed, gaining and losing support or "valence" in the group. Bass (1977) speaks of goal setting, information sharing, and consulting with others as functions necessary to effective groups.

Team performance dimensions. We propose a functional approach to defining the domain of team performance. Team performance functions specify what a team does in the interactive effort to get work done. These team functions describe the operations of the team as an entity. They do not describe the specific behaviors or skills of individual team members, although it is assumed that certain individual behaviors and skills may enable or limit team-level functions.

We propose four major categories of team performance functions:

- Team orientation functions
- Team organizational functions
- Team adaptation functions
- Team motivational functions

These functions have a number of characteristics. First, they incorporate a direct focus on task accomplishment along with a concern for the interconnectedness among team members. Second, they are relatively molar in character, and are presumed to cut across specific activities occurring in the team. A corollary to this is that there is no one-to-one relationship between specific activities and these team functions; that is, an activity may serve several different functions. Third, these team performance dimensions are intended to be relative rather than nominal categories. This implies that various team performances can be assigned values on these dimensions such that they can be ordered with respect to each other (Finley, Muckler, Gainer & Obermayer, 1975).

The team performance functions proposed are described in greater detail below, along with dimensions within each category.

Team orientation functions involve the processes by which information necessary to task accomplishment is generated and distributed to relevant team members. Such information includes that internal to team, i.e., team member resources and requirements, and information about the environment's resources and demands. The fact-finding nature of this general function parallels Lanzetta & Roby's (1966) definition of the orientation function, but it has the additional property of information distribution. This category partially subsumes two concepts described by Alexander & Cooperbrand (1965) as the "development of system awareness" and "development of an integrated model of the environment"--the occurrence and importance of various events and conditions. It is also similar to "team awareness" as used by Briggs and Johnston (1967), & Kanarick et al, (1971).

Among the dimensions relevant to this category are:

- Generation and distribution of relevant information about team goals and missions, including the relative importance of these goals.
- Generation and distribution of information about member resources (e.g., abilities, information, training), and consequently about their possible requirements.
- Generation and distribution of information about situational resources and constraints.

Team organizational functions involve the processes necessary for the group members to perform their tasks in coordination. They include the processes by which the team members decide who is to do what and when (Steiner, 1972). Alexander & Cooperbrand (1965) speak of team development of patterns or "programs" of coordinated behavior in response to the task environment. These functions depend on the effectiveness with which the demand resources clarification processes have been accomplished. Coordination demands a certain level of awareness within the team of task demands, member resources and situational resources.

Among the dimensions in this category are:

- Matching ~~member~~ resources to task requirements, or what is typically referred to as "division of labor."

- Response coordination and sequencing of activities, such that team member activities flow smoothly and do not interfere with each other.
- Activity pacing, which is highly related to response coordination.
- Load balancing of tasks by members.
- Priority assignment among subtasks.

Team adaptation functions include the processes which occur as team members carry out accepted strategies, make mutual adjustments, and complement each other in accomplishing the team task. The capacity for mutually complementing performances provides one of the major advantages of teamwork over work by individuals. This category encompasses what has been referred to as "cooperation."

Among the dimensions relevant to this category are:

- Mutual critical evaluation and correction of error, which imply opportunities for team members to view each others performance, the presence of sufficient common ground to enable detection of error, and a sufficiently open climate to allow for the discussion and admission of error.
- Mutual compensatory performance, which include processes by which team members perform tasks which are not typically defined as their responsibility. These compensatory performances tend to be called for in emergency situations (e.g., temporary overload on some members, equipment failure).
- Mutual compensatory timing, which includes processes by which team members informally adjust the time involved in carrying out specific sub-tasks, so that the overall task is accomplished effectively.

Team motivational functions involve processes involving defining team objectives related to the task and energizing the group towards these objectives. Stogdill (1972) refers to the energizing capacity as "group drive" -- the intensity with which members invest expectation and energy on behalf of the group. In his review of research on group productivity, Stogdill shows group drive to be an essential dimension of group performance. Team motivational functions also encompass what has been generally called "task-orientation" (Bales, 1950) and they result in high team effort and energy.

Among the relevant dimensions in this category are:

- Development of team norms regarding acceptable levels of performance
- Generating acceptance of team performance norms
- Establishing performance-reward linkages for the team as an entity
- Reinforcement of task orientation, which includes informal rewards as well as sanctions for effective performance
- Balancing overall team orientation with individual competitive orientations in the team
- Resolution of informational, procedural, and interpersonal conflicts which interfere with task orientation

Table 1 presents a summary of the four major team performance categories and the performance dimensions within each category. This table represents a provisional taxonomy of team performance.

Table 1  
Provisional Taxonomy of Team Performance

- I. Team Orientation Functions
  - A. Elicitation and distribution of information about team goals
  - B. Elicitation and distribution of information about team tasks
  - C. Elicitation and distribution of information about member resources and constraints
- II. Team Organizational Functions
  - A. Matching member resources to task requirements
  - B. Response coordination and sequencing of activities
  - C. Activity pacing
  - D. Priority assignment among tasks
  - E. Load balancing of tasks by members
- III. Team Adaptation Functions
  - A. Mutual critical evaluation and correction of error
  - B. Mutual compensatory performance
  - C. Mutual compensatory timing
- IV. Team Motivational Functions
  - A. Development of team performance norms
  - B. Generating acceptance of team performance norms
  - C. Establishing team-level performance-rewards linkages
  - D. Reinforcement of task orientation
  - E. Balancing team orientation with individual competition
  - F. Resolution of performance-relevant conflicts

### Team task taxonomies

It was stated earlier that understanding the nature and demands of team tasks is important because the tasks make behavioral demands--they define what can and should be done for successful task performance. This perspective of task as stimulus eliciting behavioral responses does not underlie most task-related taxonomies, which focus on behavioral responses rather than the task itself apart from the operator's behaviors and activities.

Previous Research. While in the minority among task relevant typologies, there are a number of taxonomies which treat the task as stimulus. There are classification schemes addressing various aspects of task content. For example, Carter, Haythorn and Howell (1950) use six categories to classify tasks: clerical, discussion, intellectual construction, mechanical assembly, motor coordination and reasoning. Hackman (1968) classifies cognitive tasks as production, discussion and problem solving. Cohen (1968) uses the three categories of sensor, control and effector tasks.

In addition to classification of task content, there are categorizations of various task characteristics. At the simplest level, tasks can be characterized as simple and complex (e.g., Shaw, 1954), or easy and difficult (Bass, Pryer, Gaier & Flint, 1958). A more complex treatment of task characteristics specifies task differences along a number of relatively independent dimensions. Thibaut and Kelley (1959), for example, describe tasks along three dimensions--state (steady and variable), requirements (conjunctive and disjunctive) and correspondence, determined by the availability of outcome to all or only some of the task group members. A systematic attempt to obtain independent group task characteristics was conducted by Shaw (1963). Based on analysis of 104 group tasks, six task dimensions were derived: difficulty, solution multiplicity, intrinsic interest, cooperation requirements, intellectual-manipulative requirements and population familiarity.

A third general class of task taxonomies focuses on interdependence in the task situation. Davis (1969) makes a distinction between additive tasks, where team members all do the same thing, and complementary tasks, which are



subdivided among the team members. Steiner (1972) called these unitary and divisible tasks. In addition, he categorized tasks as disjunctive (which requires a choice among available alternatives), conjunctive (which requires that each member perform the task), additive (which requires the summation of individual products) and discretionary (which permits combination of individual contributions as members desire).

Another system of classification speaks directly to the coordination required in a team task. Thompson (1969) proposes three types of interdependence: pooled, sequential and reciprocal. Pooled interdependence is similar to Steiner's additive condition; team members do their individual tasks with only minimal coordination needed. This condition has also been called parallel team structure (Briggs & Johnston, 1967). Under conditions of sequential interdependence, one member's activities must follow another, requiring more coordination and sequencing among team members. Briggs & Johnston (1967) call this a serial or vertical structure. Finally, the reciprocal condition requires the highest level of coordination. Team members must make continuous mutual adjustments in addition to the standard plans and schedules.

A fourth type of classification addresses the task context as well as the specific task itself. A major distinction made is that between established and emergent situations. Boguslaw & Porter (1962) define these situations thus:

An established situation is one in which (1) all action-relevant environmental conditions are specifiable and predictable, (2) all action-relevant states of the system are specifiable and predictable, and (3) available research technology or records are adequate to provide statements about the probable consequences of alternative actions. An emergent situation is one in which (1) all action-relevant environmental conditions have not been specified, (2) the state of the system does not correspond to relied-upon predictions, and (3) analytic solutions are not available, given the current state of analytic technology.

Wagner et al (1977) found the established-emergent distinction useful in their recent review of team training.

Team task taxonomies relevant to team performance dimensions. Team performance dimensions have been defined as those processes which enable the team to function as a unit, rather than as an unorganized collection of individuals.

It follows that the task taxonomies most relevant to the team performance dimensions would be those that address the concerns of team level operations.

Task taxonomies that address themselves to task content specify what the team members are required to do in substantive terms. For example, in a cognitive production task (Hackman, 1960), team members have to generate ideas; in a clerical task (Carter, et al., 1950), they have to type or file. Such behaviors addressing task content per se are effected by individuals, albeit in a team context. Therefore, task classification systems referring to task content have most direct implications for individual task behaviors, and by extension, for individual training objectives.

In contrast, task taxonomies addressing issues of interdependence or interrelatedness among members are directly relevant to team-level concerns. There is no direct evidence for the relationship between certain conditions of interdependence and various team functions, although certain hypotheses can be made. In a recent review on team productivity, Bass (1977) suggests the following associations, based on Thompson's (1969) types of interdependence:

<u>Impact on</u>	<u>Required Interdependence</u>		
	<u>Pooled</u>	<u>Sequential</u>	<u>Reciprocal</u>
Coordination required	Low	Medium	High
Need for open communication	Low	"	"
Alertness to other team members	Low	"	"

A related task dimension which has implications for team performance functions required is the established-emergent continuum, which specifies the extent to which performance strategies, roles, and conditions are pre-defined. The degree to which interactive and coordinative activities are required in a task context would depend greatly on the task's position on this continuum.

While interdependence and emergence are two major team task dimensions considered critical to concerns of team performance and training,

others may emerge in future research.. Identification of these two important team task dimensions should be regarded only as an initial step in the development of a team task taxonomy relevant to team performance.

Figure 2 illustrates the linkages between the task and performance taxonomies discussed.

	TASK TAXONOMIES	TEAM PERFORMANCE TAXONOMIES
Individual Level	Task Content	Individual Performance Dimensions
Team Level	Task Interdependence Task Emergence	Team Performance Dimensions

Figure 2  
Linkages between Team Task and Team Performance Taxonomies

## Potential Utility of the Team Performance and Team Task Taxonomies

Parallel team performance and team task taxonomies, each differentiated according to individual and team levels of analysis, provide a useful way of characterizing the work team situation. The information generated by analyzing the work situation using these systems can have a variety of potential applications.

For those interested in team training and/or evaluation, the team performance dimensions can present answers to the basic criterion questions: "What is to be trained?" or "On what are teams to be measured for proficiency?" These dimensions may also have utility for job analysts, who can use them to define team performance requirements in a given team work situations.

The dimensions we propose are meant to supplement individual performance dimensions, which describe the activities of or training requirements for individuals within the team. The two levels of analysis i.e., team and individual, must be addressed by any effort to improve team effectiveness, since team performance rests on individuals carrying out specific sub-tasks as well as on the coordination and interaction of such individual activities.

It would be desirable to be able to characterize team tasks along a few dimensions which can provide some guiding boundaries for the performance functions required for task achievement. For example, if a team task situation is high in task interdependence, this should imply a correspondingly high demand for the team performance functions "response coordination" and "activity pacing". Such a system would be a useful way to place diverse tasks in relatively rough groupings which have known performance requirements. At this point, however, further work is required to identify important task dimensions which can be used in this manner, and to conceptualize the specific relationship between the team task and team performance functions.

## CHAPTER 4

### Recommendations for Future Research

The development of a conceptual model of team performance and the identification of important team performance and team task dimensions are regarded as initial steps in a programmatic research effort on team evaluation and training. Some needed next steps include:

1. Further development of team performance and team task taxonomies. Continued conceptual effort is necessary to develop further the team performance and team task taxonomies. These efforts should be directed at examining more closely the nature of the dimensions proposed, their comprehensiveness and level of specificity, relationships among the various dimensions and identification of possible overlap and missing elements. In addition to developing the task and performance taxonomies independently, the relationships between task properties and team performance functions should be defined and explored empirically. Examples of relevant lines of inquiring might be: 1) Can the requisite team functions be identified for given conditions of task interdependence (e.g., pooled-additive or sequential-serial)? or 2) What type of team functions are not appropriate, or are obstructive to task success, given certain task conditions?

2. Development of instruments to measure team performance requirements and proficiencies. Methodologies are needed to evaluate teams along the team performance dimensions identified. These methods would be needed to define the performance requirements of teams, and to assess the extent of which team performance meets these requirements. Several methodologies for assessing teams have reached a stage of development for possible application to the group performance area--binary decision flow diagrams, behaviorally anchored rating scales, and profile-analytic methods. These three methodologies answer somewhat different questions, and thus are to be regarded as complementary to each other rather than as possible substitutes. They need to be tested for feasibility and utility in measuring actual team performance along the team performance dimensions developed and for their relations to mission accomplishment.

Binary decision flow diagrams are particularly applicable to purposes of identifying whether certain performance dimensions are present or required rather than to purposes of quantifying the extent to which they are present (Levine, Mallamad & Fleishman, 1978). They have been used previously as aids in assessing the ability requirements in task performance (Fleishman & Stephenson, 1972; Levine, et al, 1978). The methodology is an innovative one which appears to be potentially applicable to the assessment of team requirements and team performance. It involves proceeding through a series of binary decisions as to whether a performance dimension was required or exhibited by a team carrying out its task.

Figure 3 presents an early version of a binary decision diagram developed for assessing ability requirements (from Fleishman & Stephenson, 1972). The application of such an approach to the team performance dimensions should be tested. However, more extensive conceptual development of the team performance dimensions is necessary before decision flow diagrams can be constructed for team performance dimensions.

Behaviorally anchored rating scales can be developed to quantify team performance requirements or proficiencies. They were devised originally by Smith & Kendall (1963) as a way of minimizing the high level of ambiguity characterizing conventional rating scales. This methodology has been applied with success to a number of settings, and has typically enjoyed a number of advantages, among them, specificity of behaviors observed, emphasis upon observation, lack of ambiguity about the meaning of the anchors and high scale reliabilities (Smith, 1976). The procedures to be used in developing anchored rating scales for team performance dimensions follow those developed by earlier studies in the ability taxonomic research program (e.g., Fleishman, 1975; Theologus, Romashko & Fleishman, 1973; Fleishman & Hogan, 1978). With minor modifications they can be designed to assess team task requirements as well as to evaluate actual team performance along specific dimensions. The team performance dimension will be defined, reflecting high and low amounts of each dimension. As a second step, dimension-specific behavioral anchors are placed at each end of a 7-point scale. ~~Figure 4 presents~~ a prototype of an anchored rating scale for evaluating teams on the team performance dimension, response

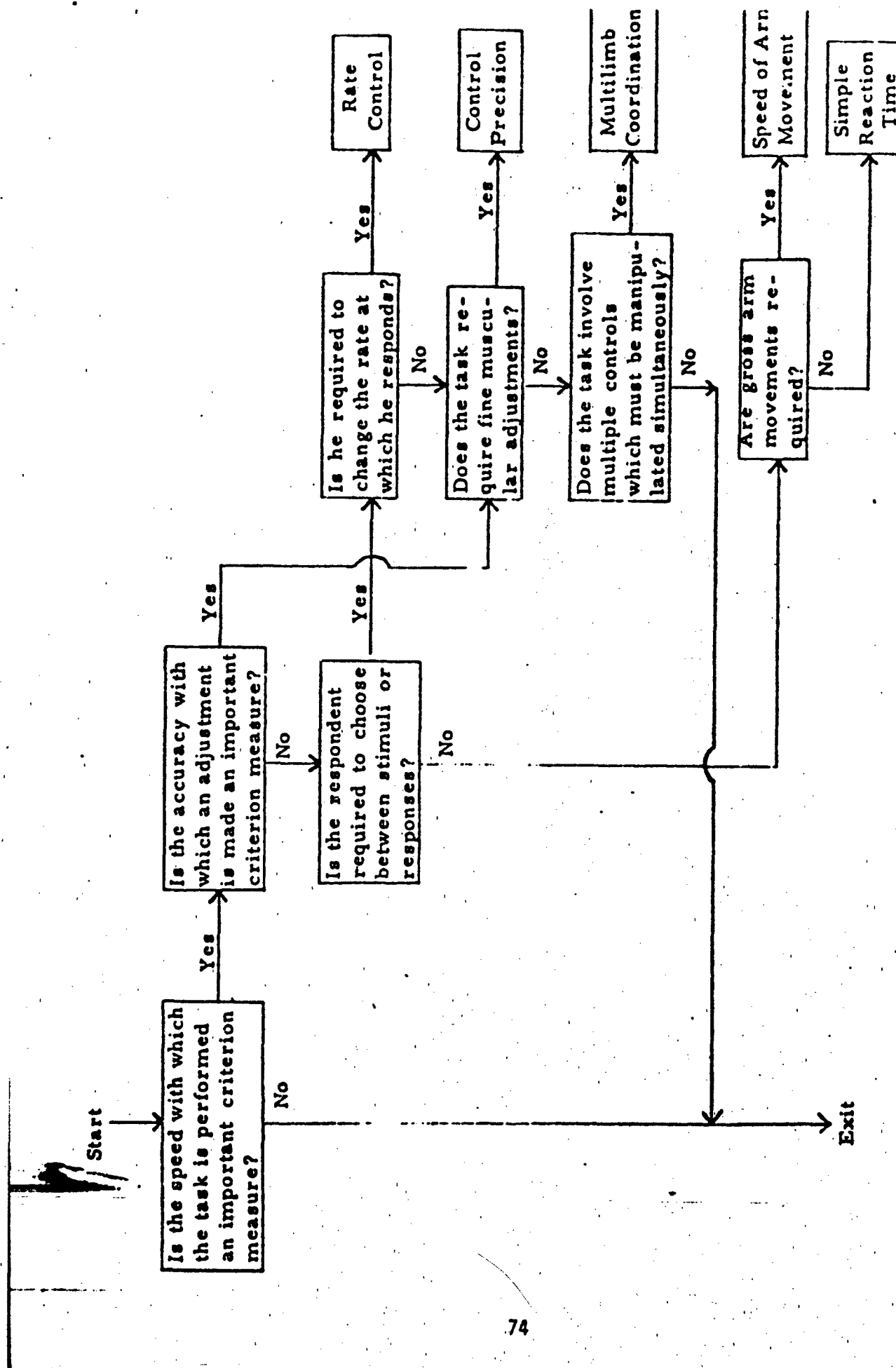
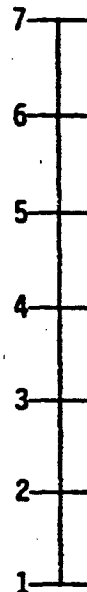


Figure 3 Early version of one binary decision diagram.

## RESPONSE COORDINATION

This dimension involves the extent to which team members are able to achieve order among their activities, such that there is a smooth flow and minimal interference or obstruction among activities.

Very high response coordination:  
team work proceeds smoothly with  
no work stoppages and interrup-  
tions.



Very low response coordination  
in the team: team work is con-  
stantly interrupted due to lack  
of clarity or disagreement among  
team members about order and pro-  
cedure; members frequently get in  
each others way.

Figure 4  
Prototypic Anchored Rating Scale  
for Team Performance Dimension  
"Response Coordination"



coordination. For the assessment of team task requirements, this scale would be modified, such that the anchors reflect requirements rather than actual performance exhibited. Also, scales for assessing task requirements would have additional anchors in the form of task examples rated as having high and low requirements for that dimension. For example, a team of snow plow operators would have relatively low requirements for response coordination (perhaps a scale value of 1 or 2), while a construction team working on a building would have relatively higher requirements for response coordination (perhaps a 5 or 6). These task anchors would have to be derived empirically, based on guidelines described in Fleishman & Hogan (1978).

Profile analytic approaches (Nunnally, 1967) provide promising directions for team performance measurement. Instead of locating the position of teams on one dimension at a time, teams may be assessed relative to each other or relative to an ideal on profiles which encompass a number of dimensions. Figure 5 provides a hypothetical illustration of profiles on a task which stipulates only the relative importance of subtasks, but does not assign members to specific tasks. Team profiles would provide three major types of information: level, dispersion and shape. Level is defined as the mean score of the team over the variables in the profile. Such a measure would only be meaningful if the variables come from related domains, as for example, the dimensions within the team-organization category. Dispersion measures would indicate the divergence or scatter from the average level. Finally, shape concerns the high and low points in the profile; given the same level and dispersion, team A may be highest in variable 1 and lowest in variable 5, whereas team B may have just the opposite pattern.

Methodological feasibility of each approach can be defined in a number of different ways. One useful criterion for utility, used in studies which examine the utility of ability as a basis of task classification (Theologus, Romashko & Fleishman, 1973) is rater agreement on dimensional ratings on a variety of tasks. Applying the basic paradigm used in these studies, subjects may be asked to rate an array of team tasks in our team performance dimensions using one methodology each. Given the degree of abstractness involved in the dimensions, the raters will have to be provided conceptual and observational training, as part of the research procedures. Initial

Team Performance Dimensions

- A. Matching member resources to task requirements
- B. Response coordination
- C. Activity pacing
- D. Priority assignment among tasks
- E. Load balancing

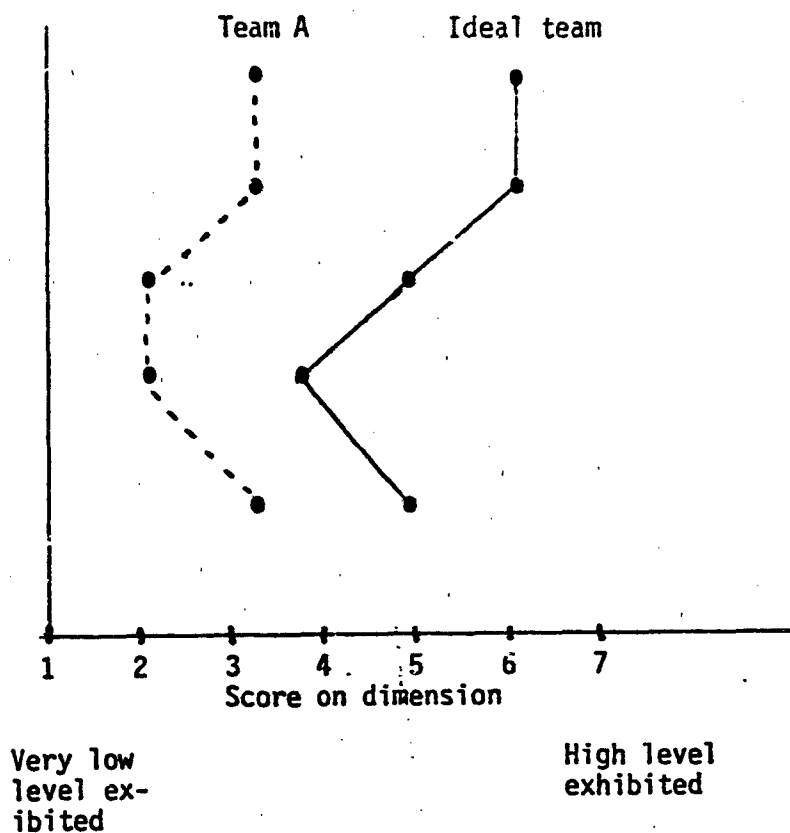


Figure 5

Profile Comparison of Teams on Team Organization  
Performance Dimensions

work can be conducted under relatively controlled conditions, using video-taped teams performing a variety of team tasks. The nature of the tasks, as well as the type of raters (students, psychologists, job incumbents) can be varied.

3. Investigation of meaningfulness of team performance dimensions.

In addition to testing feasibility, studies should be conducted to explore substantive questions concerning the meaningfulness of our dimensions such as:

- How do team performance dimensions contribute to various distal criteria (e.g., speed, quality of product) of team effectiveness?
- Do teams defined a priori as effective and ineffective differ along the team performance dimensions developed?
- Which dimensions tend to have significant effects across task situations, and which ones are most susceptible to variations in the task environment? In other terms, are some dimensions generally more critical than others?
- Do these team performance functions have any time-related patterns? Are there identifiable sequences in these functions?

In exploring the meaningfulness or significance of the performance dimensions developed, it may be more effective to utilize real operational work teams, rather than ad hoc, artificial laboratory teams. This is particularly true in trying to determine the criticality and universality of performance dimensions. Field research, wherein control is introduced statistically rather than by experimental conditions, can be conducted in ongoing work teams (assuming permission can be obtained) in the Army or other settings, or in task and gaming simulations such as those conducted in graduate schools of business. In these studies, close attention would be paid to the nature of the work team and task.

4. Further exploration of the team performance model. In order to achieve greater understanding of team performance, the relationships among the different sets of variable sets must be explored. While each linkage portrayed in the model deserves exploration, the most critical and least understood are the relationships between individual performances and team performance functions. In addition to exploring the individual linkages, it is time to investigate systematic relationships among the variable classes

acting in concert. The examination of specific bivariate relationships, which constitutes the bulk of research done thus far, identifies for us the critical classes of variables affecting team performance. However, the study of bivariate relationships will not provide us with the necessary understanding of the complex interactions among variables, as they fully interact in actual situations. Path analytic and regression procedures would be useful in determining such interactions as well as the relative importance of different variables in forecasting team outputs. Such an investigation would not take the form of the standard laboratory small group study, but would focus on task groups with real tasks in uncontrolled field studies or complex simulations of working groups.

5. Development of standardized assessment batteries. Conceptual and methodological work on team performance dimensions can eventually serve as the basis for the development of standardized assessment batteries on which team proficiency can be tested in a controlled situation. This would involve the development of standardized tasks which can be manipulated to reflect variations in task characteristics and requirements. In the individual performance area this approach is reflected in the work of Alluisi (1967) and Fleishman (1967, 1975).

A wide variety of team assessment instruments, e.g., team work on an electrical apparatus (Lanzetta & Robby, 1960), programmed simulations (Driver & Hunsaker, 1972) and managerial assessment centers (Finkle, 1976) have been used to assess a range of concerns. A first step in the development of standardized batteries would be a review of existing methodologies, and an analysis of their potential utility to the team performance dimensions developed. However, it is anticipated that existing instruments will have only limited applicability for our dimensions, and that significant effort will be required to develop a standardized battery. Such a research effort would only be undertaken upon further development and understanding of the team performance dimensions.

6. Development of training systems to develop team effectiveness. With the understanding of team performance and team task dimensions, along with appropriate measurement capability developed in steps 1, 2, 3 and 4, one may conceive of the possibility of designing team training systems aimed

at developing team effectiveness. This implies integrating training of individuals in specific procedures and operations, with training of the team as a unit. Therefore, training specifically geared towards proficiency in team performance dimensions must be developed to supplement or be integrated into present approaches to military team training, e.g., SCOPES (Squad Combat Operations Exercise Simulation) or REALTRAIN, which are geared towards teaching individual skills within a group context (Wagner et al, 1977). The development of such training systems can be anticipated to be a difficult process. The usefulness of a number of new technologies, e.g., split or multiple screen televisions (Kanarick et al) or computer assisted systems (Hausser et al, 1976), can be expected in addition to traditional training and instructional technologies.

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APPENDIX A

TEAM DIMENSIONS LITERATURE ABSTRACTING FORM

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1. Complete Reference (APA format)

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2. Abstract

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3. Type of study (laboratory or field; experiment or survey)

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4. Independent variables (e.g. group conditions, tasks)

Name

Operational definition

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5. Dependent variables - Performance measures

Name

Operational definition

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6. Subjects

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7. Comments